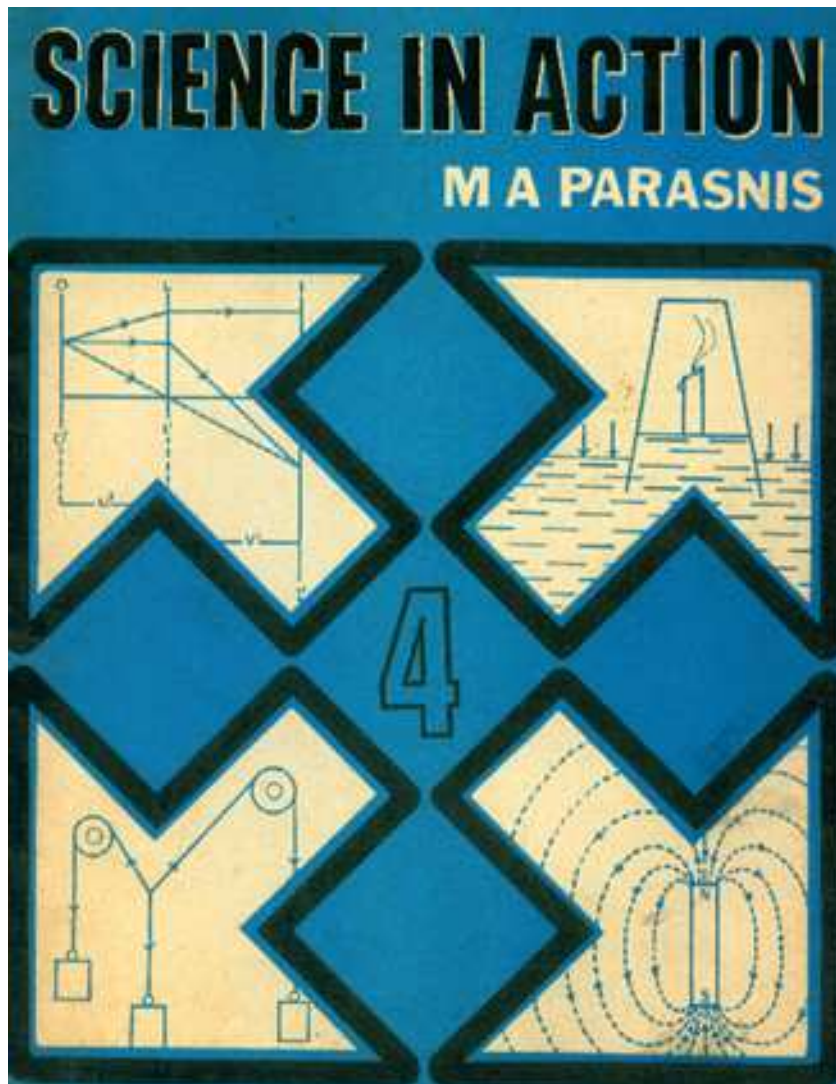




SCIENCE IN ACTION

M. A. PARASNIS

BOOK 4

PREFACE

Doing an experiment is fun
And is the best way to learn

The series 'Science in Action' is written specially to help children in the age group eight to thirteen years to have first hand experience in science. It

is designed so as to help the classroom teacher make the learning of science an enjoyable and rewarding experience for herself/himself as well as for her/his class. Interested parents could also easily use the series to help their children to do science at home. Enthusiastic children could even use it on their own at home and school.

The series consists of five books: Book I for class four (age 8-9 years), Book II for class five (age 9-10 years), Book III for class six (age 10-11 years), Book IV for class seven (age 11-12 years) and Book V for class eight (age 12-13 years). It is not designed to cover the syllabus of any particular school system or state but, rather, to uncover a little part of the fascinating world of science, taking into consideration the average mental and physical capabilities of the respective age groups.

Essentially these are books of science activities. These typical activities, selected from various areas of science, use *readily available* and *Inexpensive materials* like jam and milk bottles, coffee tins, paper cartons, thread, string, wire, paper clips and pins, rubber bands, balloons, drinking straws, etc. Many classic experiments, described in text books unchanged for generations, have been performed more interestingly and instructively. Many more have been added. Each activity has been tried and tested out, so to say, in the *field*. They all involve experimentation resulting in experience with important scientific principles. The involvement is qualitative and thus maintains a high level of interest.

These books are the culmination of a decade of involvement in school education (on the campus of the Indian Institute of Technology Kanpur) into which I was initiated and inducted by the Institute's first Director, Dr P K Kelkar. It was his faith in the tremendous potential of children and his keen insight into the way they learn which made him start a school on the campus under IIT/K Administration. The School had complete freedom to try out new methods in teaching and learning. It was at the IIT/K Campus School that many of the seeds of the present series were sown. It was the encouraging response from children and teachers of that school that gave me the enthusiasm to complete the work.

Thanks are due to the Education Development Centre, IIT/K, funded by NCSE/NCERT, for grants which have supported this venture and have made it possible for each and every activity in this series to be actually tested out.

For books such as these good illustrations are essential. They save many words of description and are a special attraction for the children. I would like to record my appreciation for the patient and painstaking work done on

illustrations by Mr. A C Joshi of the Department of Electrical Engineering, IIT, Kanpur.

My husband, Dr Arawind S Parasnis, Professor of Physics, IIT, Kanpur, has read the manuscript critically and made innumerable valuable suggestions. He and my sons, Kaushik and Gautam, have provided that understanding cooperation without which I could not have enjoyed writing the series. My sons were often the guinea pigs for testing out these activities.

The series is dedicated to children—the mini-scientists—and their teachers. If you have enjoyed the books, do let me know along with corrections and comments, if any.

Meera A. Parasnis

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INTRODUCTION

Science today plays a significant and ever-increasing role in the social and economic life of ordinary man. The impact of scientific and technological progress not only has permeated urban and suburban life but also is fast penetrating into remote villages. New varieties of seeds, the tractor, the transistor radio and the antibiotics have reached the farthest corners of our country. Many villages have been electrified. Satellite Instruction Television Experiment (SITE) has already taken television to a number of villages. Training in science is essential to the improvement of health and living conditions of our people and to the promotion of agriculture and industry. It is, therefore, increasingly important for everybody to be literate in science. This need embraces all age-levels, all socio-economic levels and all intelligence levels. However, it is for the children of today, the arbiters of our fate tomorrow, that the need is the greatest. Unless we give our children scientific schooling we cannot hope for a bright future for our country.

Till very recently, no one studied science unless one entered middle/high school. Some schools did teach a few lessons about birds and flowers. All that was available was a few books of nature stories and study.

Since Independence the field of science education has undergone a big change. Most of the changes stem from a dual attempt. First, there has been an increase in the quantity of subject matter taught. Second, there has been an attempt at re-establishing the class levels at which various topics would be taught: a part of what was done in high school is now sought to be done

in the middle school and, in the same way, a part of what was done in the middle school is sought to be handed over to the primary school.

However, students are doing more reading in science. They are reading about science but not doing science. This is like attempting to teach a person to swim by having him read the best books on swimming rather than plunge into water.

In short, the science programme in our schools is still around the text books. Science is viewed by teachers (and consequently by children) as a body of facts and a set of answers, absolute and immutable, which explain the universe. Often these explanations come in the form of one word or phrase taught by the teacher and learnt by heart by the taught. When a phenomenon is demonstrated, the children simply associate the questions about the phenomenon with the word or phrase without understanding conceptually the interactions involved. Natural phenomena are used not as stimuli to regenerative thinking and to the spirit of discovery but merely as examples of or adjuncts to facts already presented. Thus a bug floating on water is an example of surface tension. A ship, though made of steel, floating on the sea is an example of Archimedes' principle. The horse pulling the cart and the cart pulling the horse is an example of Newton's law of reaction. Can we blame the child?

This inevitably helps erect a barrier between the child and science. This barrier must be broken. When such barriers are broken science becomes not only interesting but also a part of the child's thinking. This requires a child's active involvement in his own learning. Experimenting is an excellent chance to stimulate thinking. There is joy and excitement in working with one's own hands for man is basically a builder. Children need to work with their own hands and talk and argue about their work. They should get involved with science and discover its principles for themselves. As far as possible, even demonstrations by teachers should give place to investigations by children. Children should work like little scientists busy exploring the rich world around them. It was a very wise Chinese sage who said

I hear and I forget

I see and I remember

I do and I understand

Performing experiments and learning to make close observations requires some facilities. These are lacking in most of the schools of our country—especially at the primary and middle school levels. As a result, science

teaching (if it is attempted at all) suffers from a severe handicap especially at these levels. It is often believed, though erroneously, that to introduce science experience even in primary and middle schools requires elaborate equipment made by commercial manufacturers and hence needs a big budget.

The series '**Science in Action**' is an attempt to use simple, easily *available, low cost materials* to set up experiments which illustrate a large variety of sophisticated scientific principles. For example, experiments are so designed that the child does not need to use wooden planks, hammer and nails; the same work is done by cardboard, bark cork and drawing pins. The experiments are not hard to set up even if you have not done much experimentation before. The series is meant for classes' four to eight and consists of five books. These are essentially books of science activities written in a simple style so as to provide teachers, teachers-in-training and children with a variety of experiments that can be used as teacher-demonstrations, children's class room activities, demonstrations at science fairs, class projects or any related science study. The activities are interesting and instructive in practical and exciting ways.

From this year the 10 + 2 + 3 pattern of education is being introduced and science and work experience courses are compulsory up to class 10. The activities in these books involve both science and work experience. A good deal of the material needed has to be built with tins, cardboard and string. Screw driver, hammer, hacksaw, cork-borers, files and planers have to be used, depending upon the level. The contents of each book can be covered during a one year period by allotting special 'activity periods' during which children will work with their own hands to produce materials with which they will learn science. Book I has 25 very simple activities which could easily be handled by children of class 4 with two periods a week. This could be increased to four periods a week for classes 5 and 6 (Books II and III which have 30 and 40 activities respectively) and six periods a week for classes 7 and 8 (Books IV and V, having 45 and 50 activities respectively). Many concepts have been repeated from book to book so that a concept can grow to a greater degree of sophistication as a child goes to higher classes.

Each activity has five parts:

- (i) An attractive title
- (ii) Materials: the things and the equipment needed to perform the activity
- (iii) Procedure: Step by step utilization of the materials. The expected observation is usually indicated as a part of the procedure

(iv) Drawings and diagrams: for ease of assembling

(v) The ‘why’ of the activities is given sequentially at the end of each book. This gives scope to the child to think for herself/himself. In case she/he needs help it is readily available. This also acts as a check.

Believing that the method of science should play a significant role in any modern educational scheme, this series is offered in the hope that it will assist science teachers and students in their co-operative quest for science.

FOREWORD

It is a matter of great pleasure and honour to have this opportunity of writing a Foreword to the rather unique series of books entitled ‘**Science in Action**’ meant for children below thirteen years of age written by (Mrs) Meera A Parasnis. The time of its publication could not have been more appropriate for there seems to be a new awareness in the country of the need to make science education meaningful from the earliest level of schooling right up to the tenth standard.

Modern technology is revolutionising our entire social structure in a variety of ways. The pace of change poses challenges in every direction. It is possible neither to go back nor to advance in a systematic manner without a proper understanding of the way technological forces affect society. It is necessary to appreciate that if the fruits of technology enter the lives of men; its roots are in science. In this context understanding of science and the scientific method is as necessary for those who are going to be professional scientists as for the rest.

The essential objective of the teaching of science to children must be not so much the imparting of scientific information as creating a lively interest in the scientific method and developing a scientific attitude of mind by actual involvement in “scientific activity”. This is precisely what this series of five books makes possible.

In this approach the material expenses involved are very modest, but it draws heavily on the motivation of the teachers and the taught. To observe, to ask questions, to use Imagination, to make intelligent guesses about the possible answers, are all attributes of a lively scientific attitude of mind.

There is little doubt that, if children are exposed to these activities as detailed in these books over a sufficient period of time, they will not only be familiar with the scientific method but will develop a scientific attitude of

mind. Children successfully taught in this fashion will in fact begin to show the scientific approach in all their learning.

Mrs Parasnis has taken enormous pains in writing these manuals based on ten years of her direct involvement with children in the age group of 8- 13 yrs, in exposing them to real scientific activity. The material incorporated has been as though tested ‘in life’ and that is perhaps its greatest merit. In my view, Mrs Parasnis not only deserves congratulations but our gratitude for this timely publication.

If the experiment involved in using these manuals succeeds, as it should, then no time may be lost in making these available in various Indian languages.

P K KELKAR

“Chhaya”

H R. Mahajani Marg

BOMBAY 400 019

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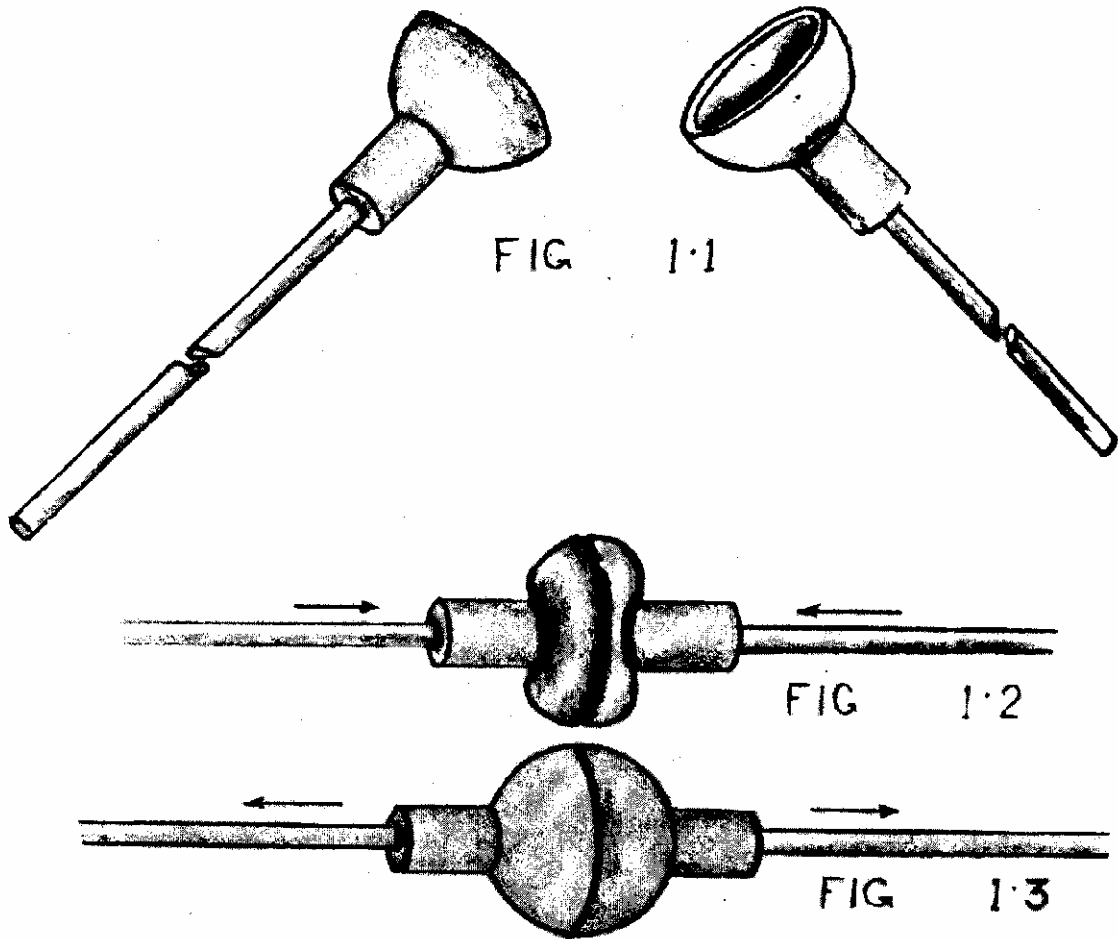
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1 Experience the Force of Atmospheric Pressure*

Materials

Two motor car valve grinders

Water



Take two motor car valve grinders (*Fig 1.1*).

Wet the rubber portions with a little water. Push the open ends together so as to drive out as much of the air between the rubber cups as possible (*Fig 1.2*).

Tell your friend to hold the stems of the cups in front of him and try to pull them apart, pulling straight out (*Fig 1.3*).

It is not so easy.

Why?

Use a single grinder to lift a book.

If you have a pair of plumber's plungers (10-15 cm), you can play a 'tug of war'.

*An analogue of the famous Magdeburg hemispheres.

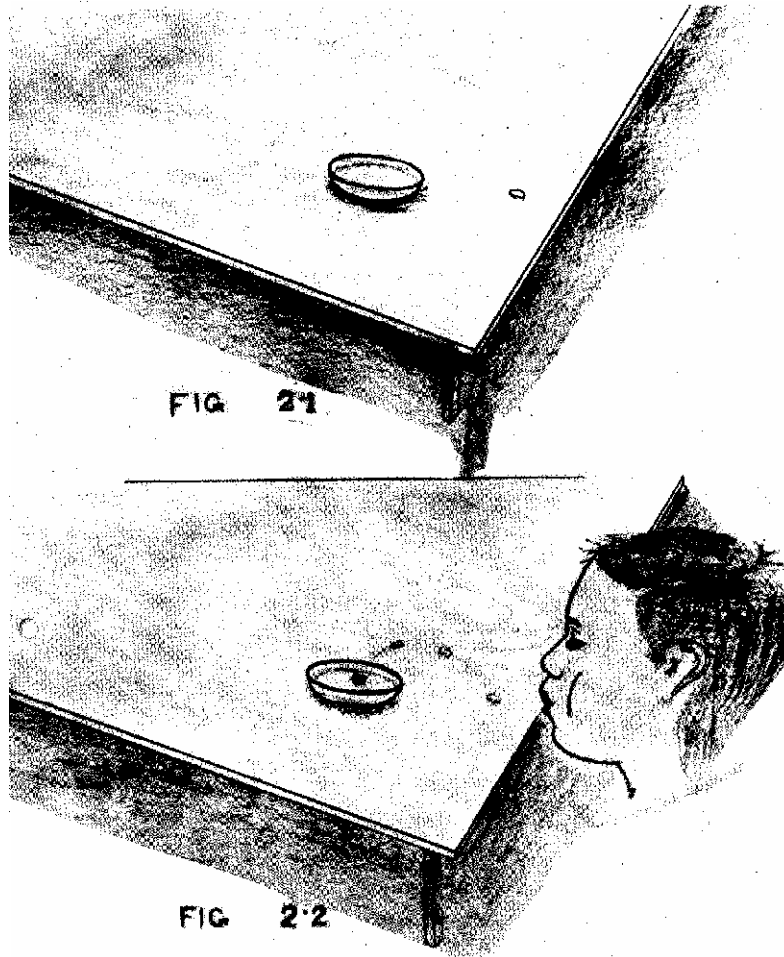
**Plumber's plungers are like valve grinders but much bigger in size.

2 Jumping Counter

Materials

*Light plastic counter** (used in dice games like ludo, snakes and ladders)

Dish (or saucer)



Take a light plastic counter from a dice game like ludo. If you do not have one, cut out a small circle of the size of a 25 p coin from thin cardboard.

Place the counter on a table about 2 to 3 cm from the edge.

Keep a dish 8 to 10 cm beyond the counter (*Fig 2.1*).

Blow a strong stream of air over the top of the coin.

What do you see?

The counter jumps into the dish (*Fig 2.2*).

Are you surprised?

Can you suggest why?

You may have to try a few times to get the proper direction and force of blowing.

*2p, 3p coins also work well.

3 Atomizer Model

Materials

Tumbler (or cup)

Two narrow enough glass tubes

Water

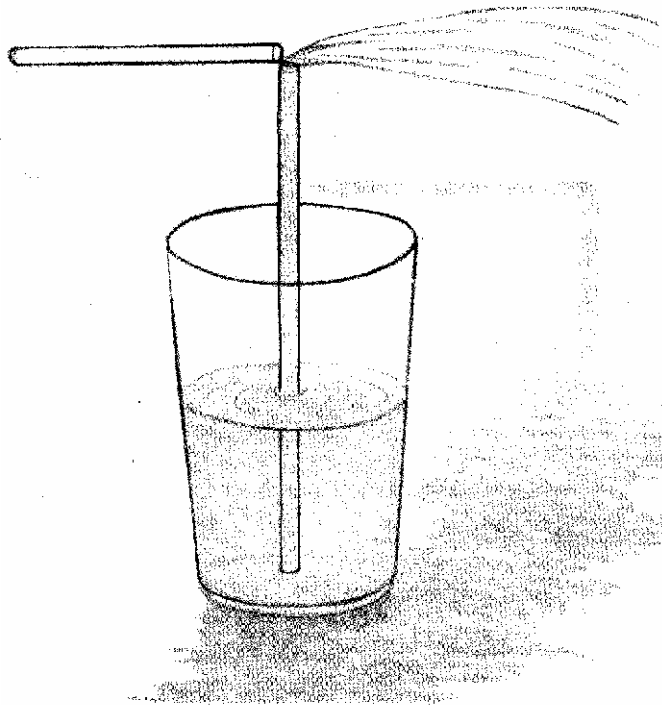


FIGURE 3

Fill a tumbler about two-thirds with water.

Put one glass tube in the water and note the level of water in the tube. The level is the same as the level of water in the tumbler (or only a little higher).

Why?

Hold the other tube nearly at right angles to the first tube, and touch them edge to edge.

Blow strongly through the second tube.

When you have it right, water from the first tube will come out as a spray (Fig 3).

Can you tell why?

You may have to try a few times before you succeed.

4 Lift of an Aeroplane Wing

Materials

Handsaw

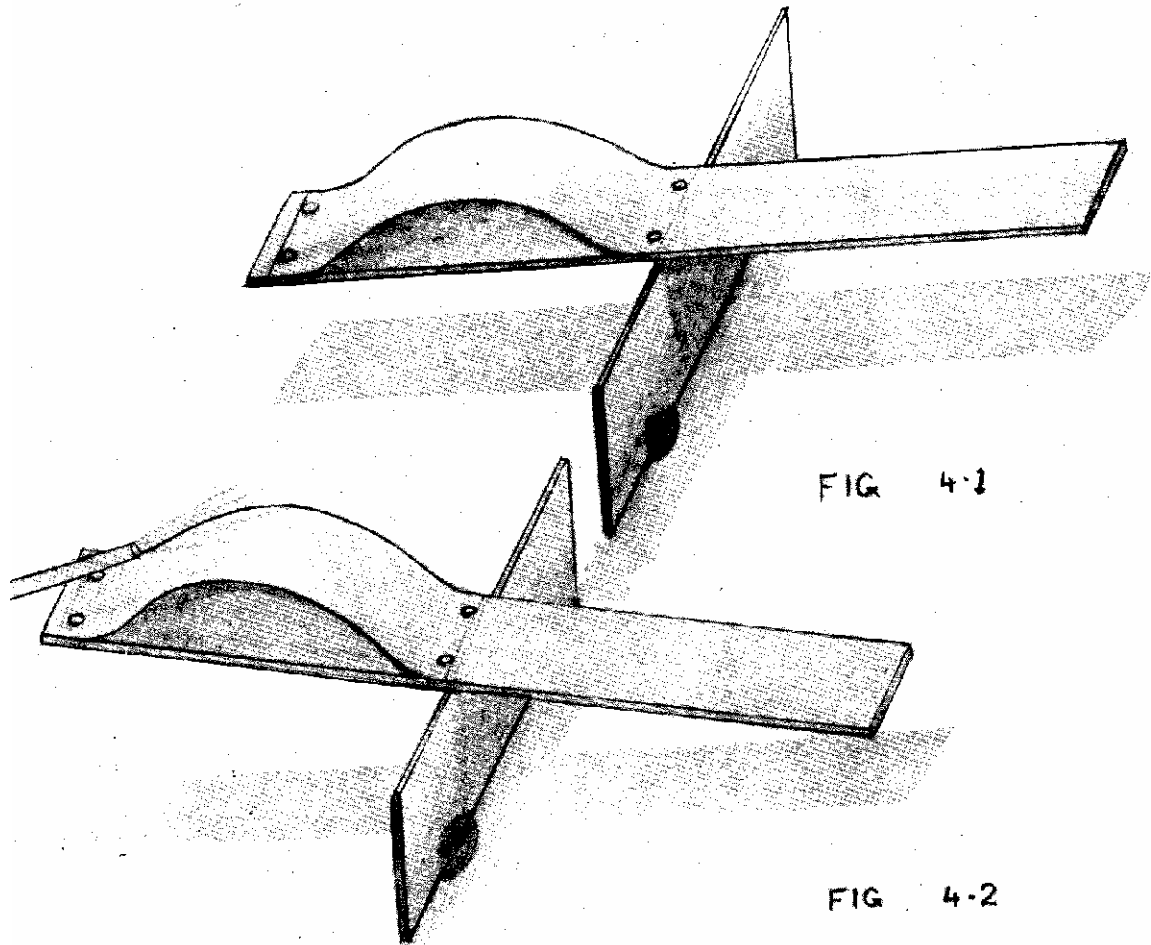
Thick cardboard

Plasticine

Thick paper

Drawing pins

Drinking straw



Cut with a handsaw two strips of thick cardboard about 30 cm x 4 cm. Use plasticine to fix one of them upright on a table.

Cut a 14 cm x 7 cm card from thick paper and pin it on one half of the other strip so as to form a hump.

Balance the latter strip (with the card) on the former (Fig 4.1).

With a straw, blow across the top curved surface of the card.

What happens?

The strip rises up on the card side (Fig 4.2).

Why?

5 Ball Dance

Materials

Glass tumbler

Water

Teaspoon

Sodium bicarbonate

Naphthalene balls

Acetic acid

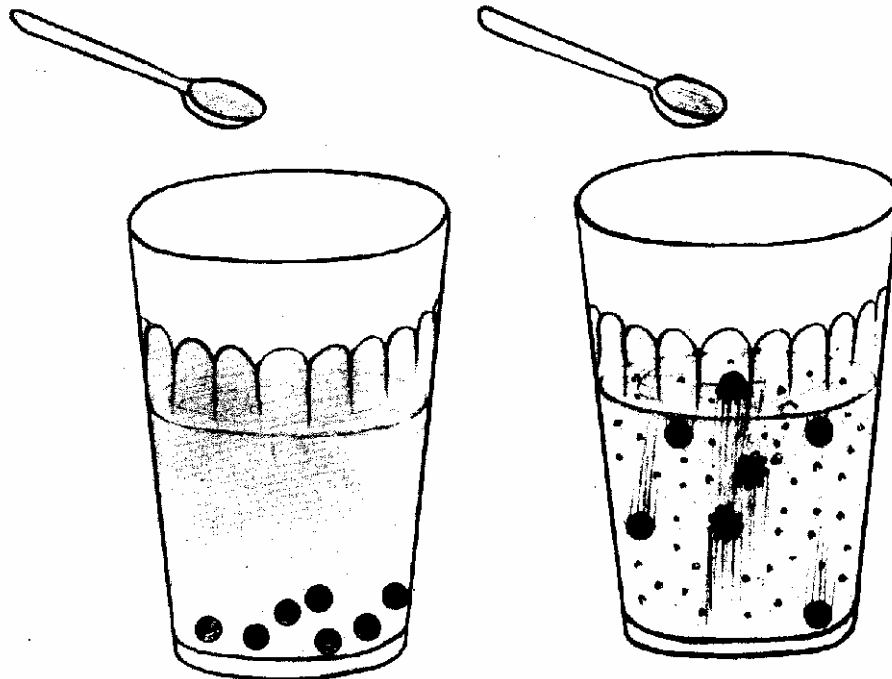


FIG 5.1

FIG 5.2

Fill a tumbler about two-thirds with water. Dissolve a teaspoonful of sodium bicarbonate in it.

Put 7 to 8 naphthalene balls into the solution. The balls sink to the bottom (*Fig 5.1*).

Why?

Add a teaspoonful of acetic acid and stir the solution. Bubbles should form in plenty*.

What do you observe?

Some bubbles settle on the balls. Slowly, one by one the balls rise to the top, *roll over* and start sinking again. Again bubbles settle on the balls and the process goes on for quite some time.

You have a ball dance (*Fig 5.2*). Why do the balls dance like this? Fresh grapes also dance in the same way.

Add a little colour to the solution (e.g. Ink or potassium permanganate) and the dancing balls stand out well against the coloured background.

*Half a cupful of vinegar to half a cupful of water to one teaspoonful of soda-bicarbonate also works very well.

6 Bottle Imp*

Materials

Big jar (or tall tumbler)

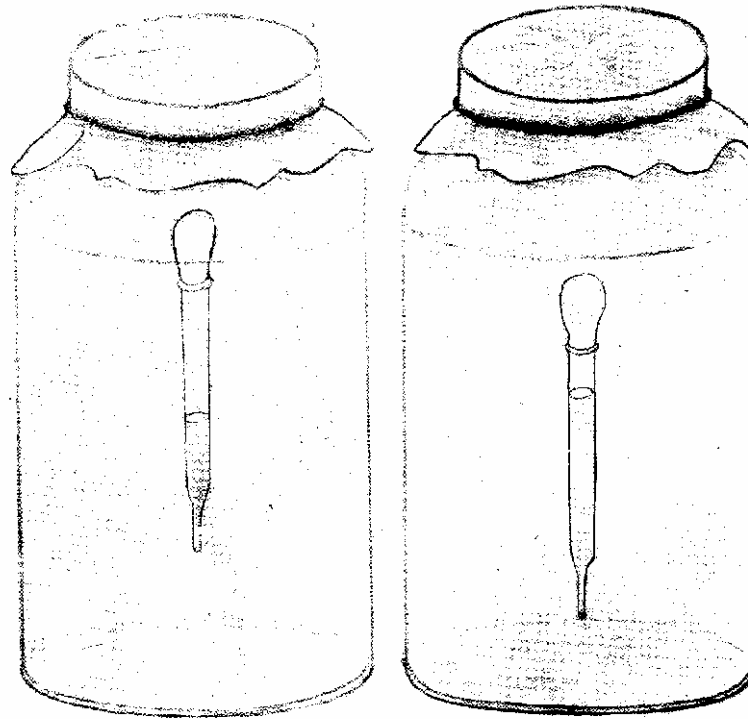
Water

Medicine dropper

Rubber balloon

Rubber band

String



BOTTLE IMP

Fill a big jar with water up to 4-5 cm from the top. Put a dropper into the water. It floats horizontally.

Take it out and fill it with enough water until it barely floats vertically (*Fig 6.1*). You may have to try a few times to adjust the dropper to just float. Cut a balloon and make a rubber cap for the jar. Tie the cap tightly with a rubber band and string. Press the cap down and release it. Repeat a number of times. What do you observe?

When the rubber cap is pressed down, the dropper ('diver Imp') goes down (*Fig 6.2*). When you release it, the diver goes up (*Fig 6.1*).

Observe the air packet inside the dropper and try to explain why the Imp is able to dive.

* A simple version of the famous Cartesian Diver.

7 Jet-propelled Balloon

Materials

Wire or thick smooth string

Drinking straw

Cello tape

Big long balloon

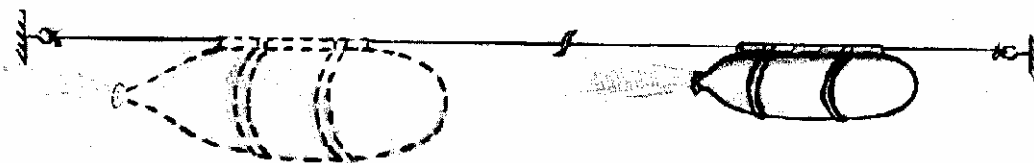
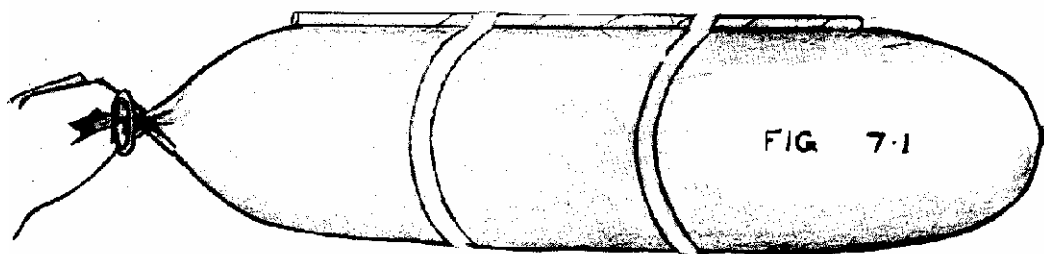


FIG 7.2

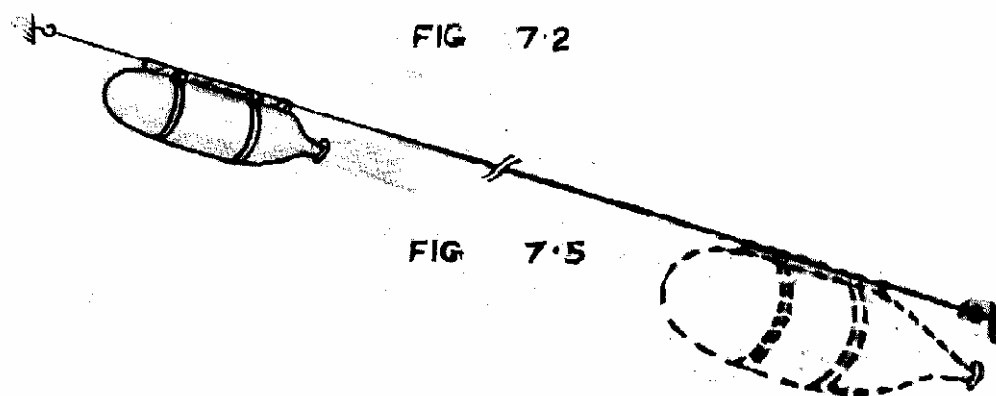


FIG 7.5

Pass a long length of wire; say 4-5 m, through a drinking straw.

Stretch the wire from one side of the room to the other and tie it to suitable supports so that the wire is horizontal. Remove any kinks in the wire.

Attach a long big balloon to the straw by cello tape. Slide the straw so that the mouth of the balloon is near one of the supports.

Blow into the balloon as much as you can and pinch its neck between the thumb and forefinger (*Fig 7.1*).

Release the neck and watch. What do you see?

The balloon shoots along the wire quite fast and travels along almost the whole length of the wire (*Fig 7.2*).

Note the direction of movement.

The air goes out of the balloon one way and the balloon (our rocket) goes the other way.

Now incline the wire upwards from the starting end and repeat the experiment.

What happens?

The balloon moves along the wire even against gravity (*Fig 7.3*).

Do you now know how a jet aeroplane flies and a rocket is fired into space?

8 Rotating Jet Engine

Materials

Cork-borer

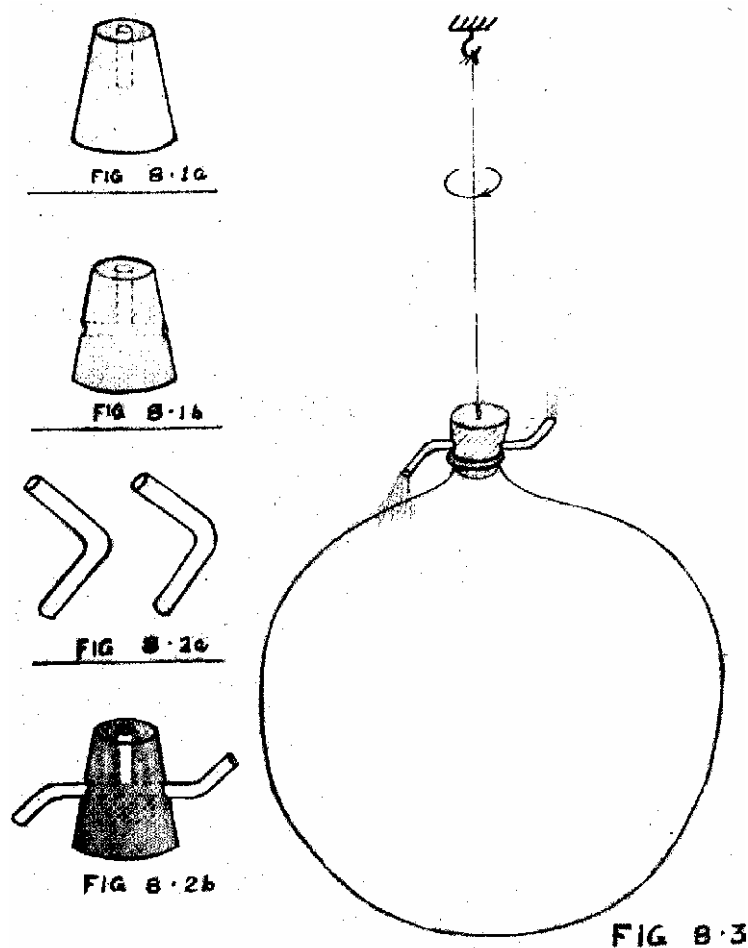
Bottle cork

Two glass tubes 8-10 cm each

Quickfix

Hooks

Thread



Big balloon (preferably round) Using a cork-borer make a T-shaped hole in a cork (Figs 8.1a, 8.1b).

Bend two glass tubes to form right angles (Fig 8.2*a*). Insert them into the side holes in the cork such that the open ends of the tubes point in opposite directions and at right angle to the central hole (Fig 8.2*b*). Use quickfix to keep them in position.

Screw a small hook into the bigger end of the cork. Attach a 25 cm long thread to the hook.

Tie the open end of a big balloon over the end of the cork with the opening.

Close the end of one of the tubes and blow into the balloon through the other tube.

When the balloon is full blown, hold the end of the cotton thread so that the jet engine is suspended in mid-air (Fig 8.3).

What happens?

The balloon rotates round and round and round.

Why?

Note the direction of rotation of the balloon.

9 Centre of Gravity of Irregular Flat Objects

Materials

Cardboard

String

Stone (or any small weight)

Thin nail

Pencil

Ruler

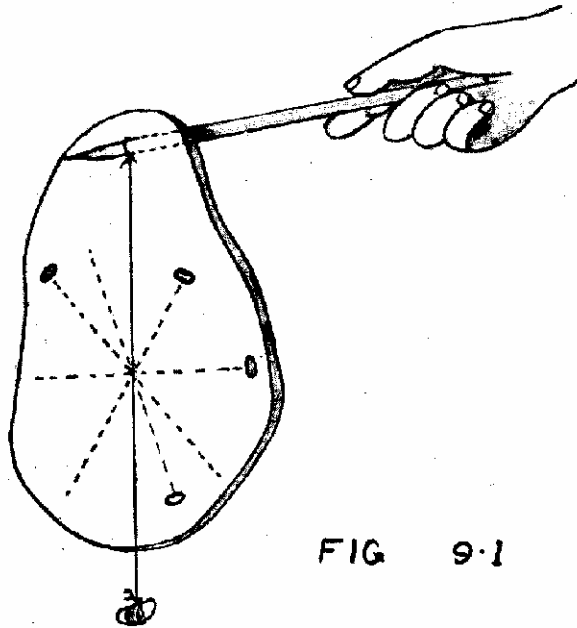


FIG 9.1

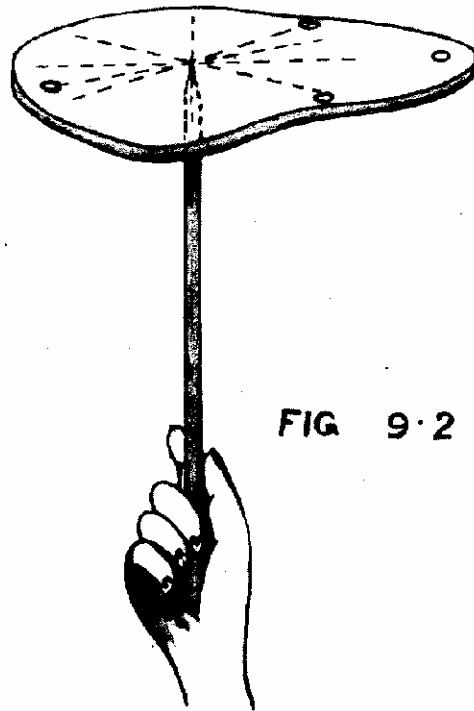


FIG 9.2

Cut out any irregular shape from the cardboard and make a number of holes in it as far away from one another as possible.

Cut a piece of string about 25 cm long and attach a small stone at one end for weight.

Tie a thin nail to the free end of the string.

Hang the cardboard shape from one of the holes with the help of the nail so that the cardboard swings freely. Wait until the cardboard and the string have stopped moving.

With a pencil, mark a line to represent the position of the string on the cardboard.

Repeat for all the holes.

What do you find?

All of these lines pass through one point (Fig 9.1).

This point represents the Centre of Gravity (CG) of the cardboard piece.

Why?

Now place the cardboard on the nail at the common point of intersection. It balances very well (Fig 9.2).

Try balancing it at any other point. It topples over.

Why?

Check if it spins easily, without a jerk, about the CG (Activity 12 Book 2).

Next cut a flat irregular shape with an irregular hole and repeat the activity to locate its CG.

Do not be surprised if the CG does not lie within the body.

10 Balanced Butterfly

Materials

Pencil Paper

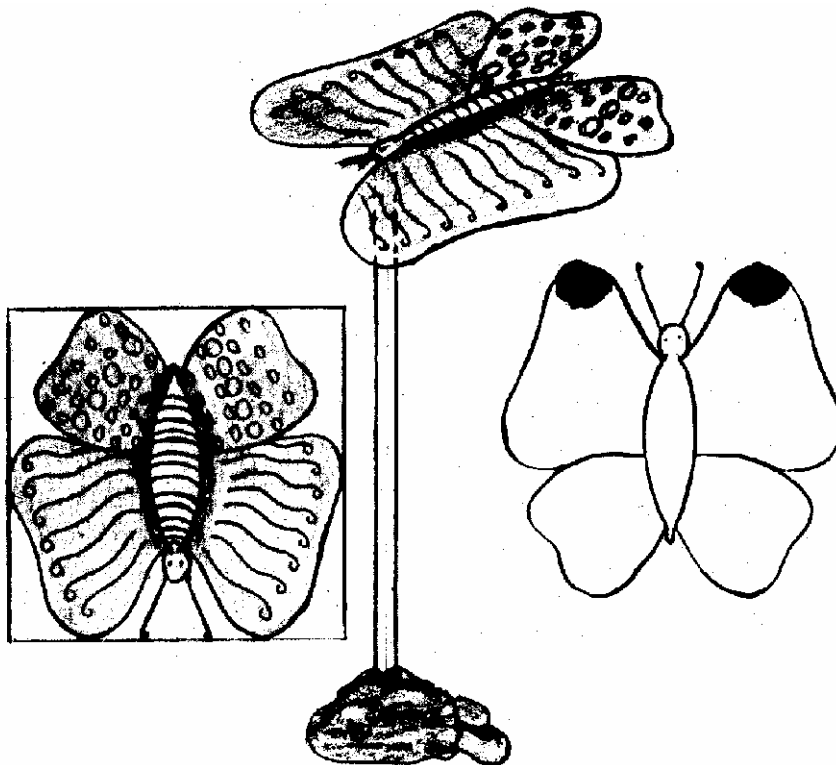
Pair of scissors

Colours (paint, wax or pencil)

Cardboard

Glue

Plasticine (or any clay)



Draw a fairly large picture of a butterfly on a piece of paper. Colour it as beautifully as you can (*Fig 10.1*).

With glue, paste it on a piece of cardboard. Cut the cardboard along the outline of the butterfly. You now have a colourful cardboard butterfly.

Here is how you can balance it on the tip of its nose.

Make two equal balls of clay and press one each to the ends of the front wings on the underside (*Fig 10.2*).

Adjust the size of the balls so that the butterfly balances on the tip of its nose when placed on the end of a pencil (*Fig 10.3*).

Gently push the wings down and let go. What happens?

The butterfly is well balanced. It rocks here and there and finally returns to the original position. It is quite stable.

Why?

Find the exact CG by the method of Activity 9. You can now balance it on the point of a well sharpened pencil.

Now ‘invent’ a *balanced toy* of your own, say an aeroplane, an animal, a clown etc. Try three dimensional toys also.

11 Rocking Clown

Materials

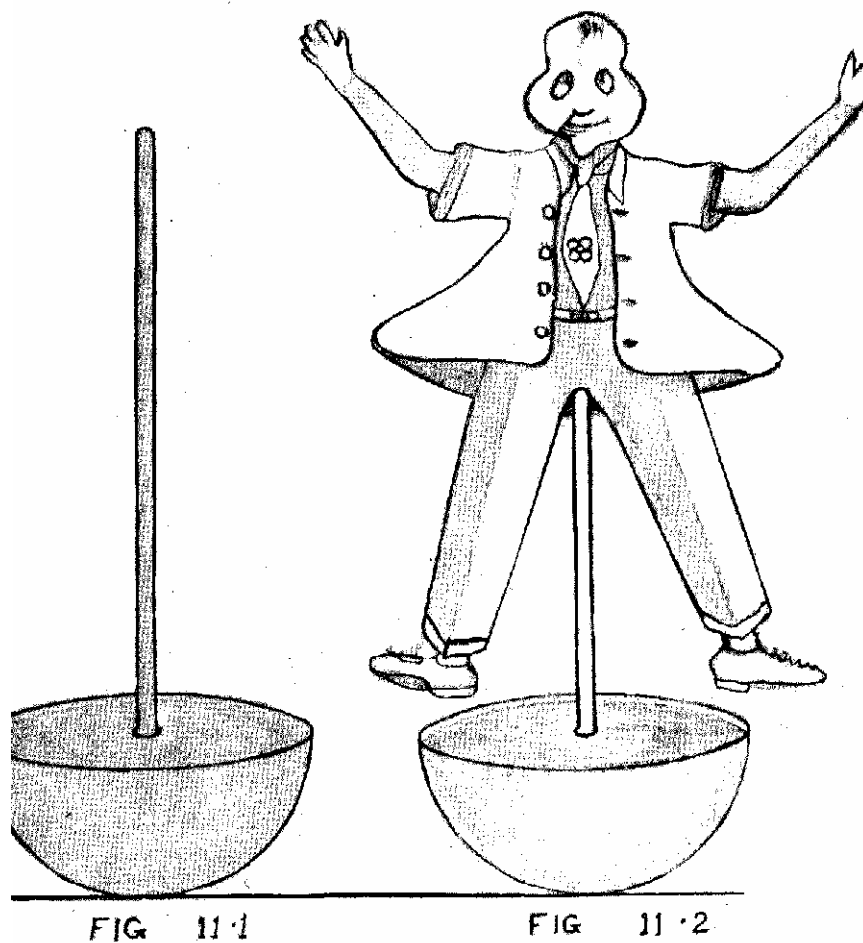
Old rubber ball, ping pong ball or coconut shell

Pencil or thin wooden rod

Plaster of Paris (or candle wax or any modelling clay)

Thick paper

Cello tape



Cut an old rubber ball in half.

Fill one half of the ball with wet plaster of paris and place a pencil (or any thin stick) into the centre of the clay (*Fig 11.1*).

Allow the plaster to set.

Cut out a paper clown from thick paper and with cello tape attach it to the pencil (*Fig 11.2*).

Tilt the clown down until its feet touch the table.

Let go.

What happens?

The clown rocks a little and finally stands upright again. Do what you may; the clown always comes back to the straight position.

Why?

Materials

Table

Two metre (or half metre) scales

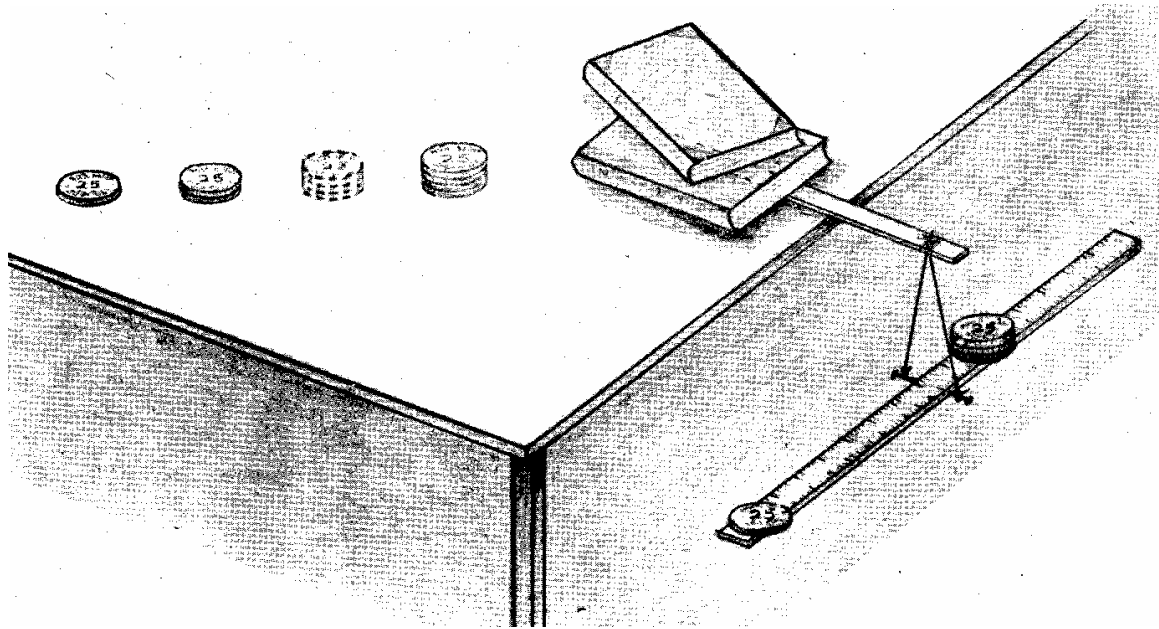
Heavy books

Pins

String

Plasticine

A number of coins (say 25 p)



Keep a metre scale under some heavy books on a table such that a part of the scale projects out.

Fix two pins on the opposite edges of another metre scale at the 50 cm mark. Tie two equal lengths of -string one to each pin. Bring the two strings together and hang the second scale from the first scale (*Fig 12*).

The scale will now balance horizontally. If not, stick bits of plasticine under the scale and adjust.

The scale is the *lever* and the line of pins is the *fulcrum*.

Use four 25 p coins as the *load* to be lifted and one 25 p coin as the *effort* to lift the load.

‘Place the load (4 coins) at the 60 cm mark. Find the position where the effort (1 coin) should be placed such that the two will balance. Note the distances of the load and the effort from the fulcrum.

What do you find?

A small effort is able to *balance* a great load (A slightly greater effort can *lift* the load). However, the distance of the effort from the fulcrum is much longer.

Increase the effort to two coins, three coins, four coins, etc., and find the balance point again. Measure the distances from the fulcrum—*load arm* and *effort arm*—in each case.

Do you see any relationship between the two sides of the lever?

Find the product of the number of coins and the corresponding distance in each case.

What do you conclude? Repeat for different loads.

13 Cool a Candle Flame

Materials

Thick copper wire

Pencil

Candle

Box of matches

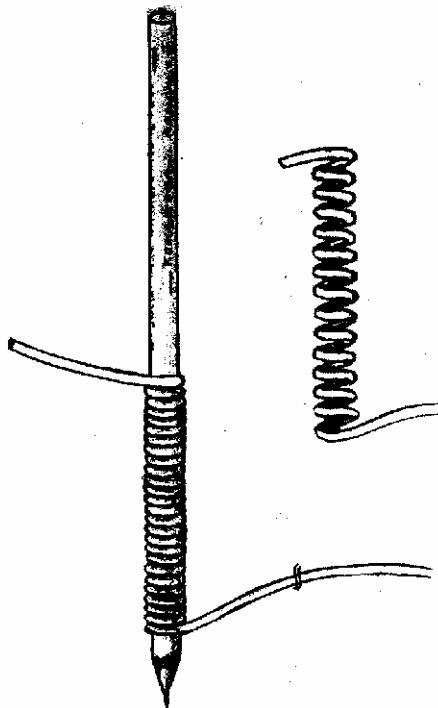


FIG 13-1

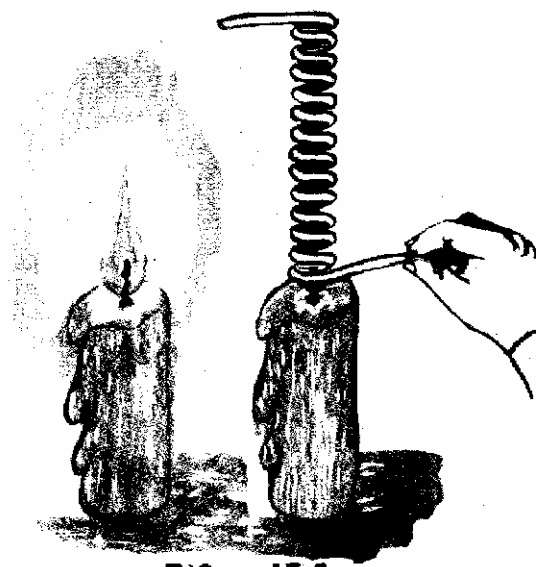


FIG 13-2

Take a long length of thick copper wire and wind it around a pencil 15 to 20 times. Leave about 5 cm of wire at either end to act as handles. Remove the pencil and you get a *helix* (Fig 13.1).

Light a candle. Lower the helical coil over the flame so that the flame is completely surrounded by the coil (Fig 13.2).

What happens to the flame?

The flame reduces in size and may even go out completely.

Why?

Now heat the spiral first and then hold it around the flame of the candle.

What do you find?

This time the flame of the candle is not affected but continues to burn.

Why?

14 Burning Candle does not burn Paper

Materials

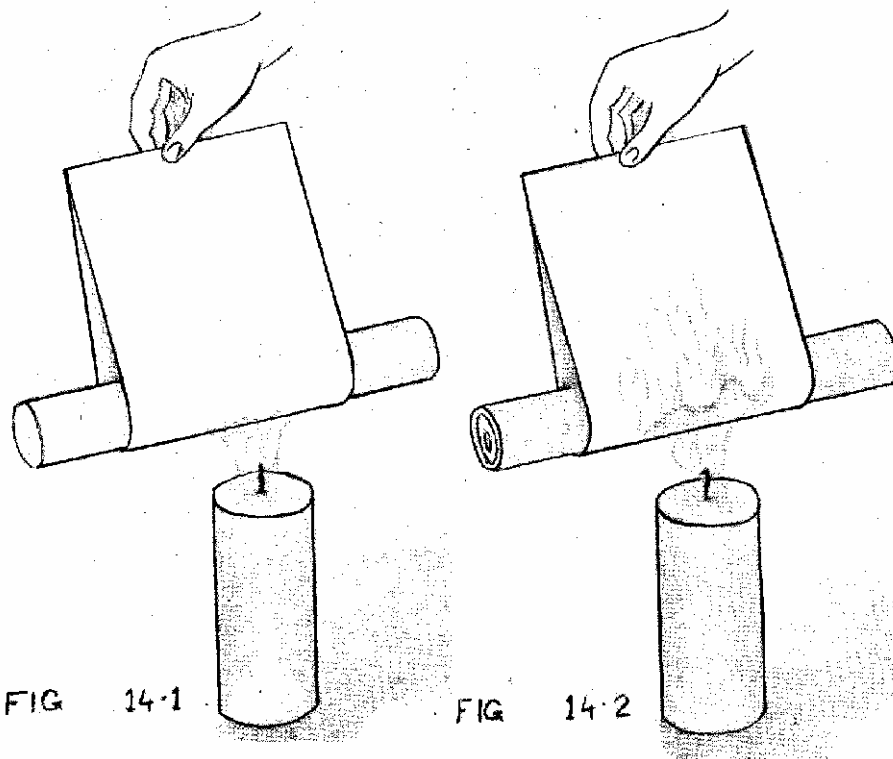
Metal rod

Paper

Paper clips

Candle

Box of matches, wooden rod



Cut out a rectangular piece of paper of breadth about two-thirds of the length of a metal rod and long enough to fold around the rod a few times.

Hold the rod by the paper so that the paper is *tightly* stretched around the rod and so that the rod does not slip out. Use paper clips if necessary.

Light the candle and heat the paper in the flame.

What happens?

The paper does not burn (*Fig 14.1*).

Repeat with a wooden rod in place of metal rod.

The paper catches fire (*Fig 14.2*).

Do you know why?

15 Ice and Boiling Water live together

Materials

Thick wire (say from a coat hanger)

Pliers Test tube Water Ice

Drawing pin

Candle

Box of matches

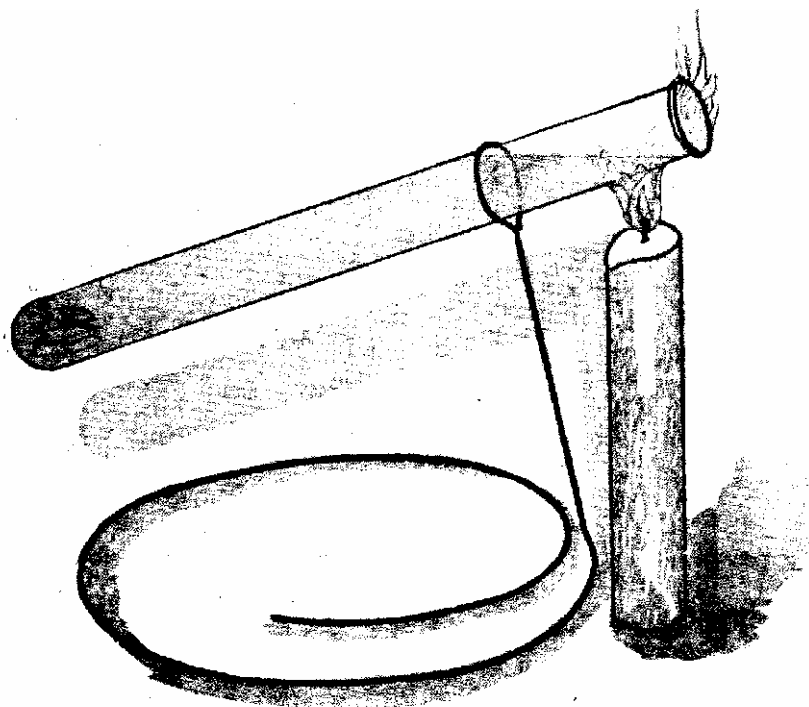


FIGURE 15

Cut out a fairly long length of thick wire.

Using pliers twist one end of the wire into a loop to-fit a test tube. Twist the other end into a large loop and bend it in such a way that the test tube (filled with water) balances well.

Fix a drawing pin into a small piece of ice and drop it into the test tube. The piece of ice sinks and stays at the bottom.

Heat the water near the mouth of the test tube in the flame of a candle.

After a few moments, the water at the very top begins to bubble and finally boil. The *ice in the some water remains as ice (Fig 15)*.

Ice and boiling water live together. Why?

16 The Three States of Matter

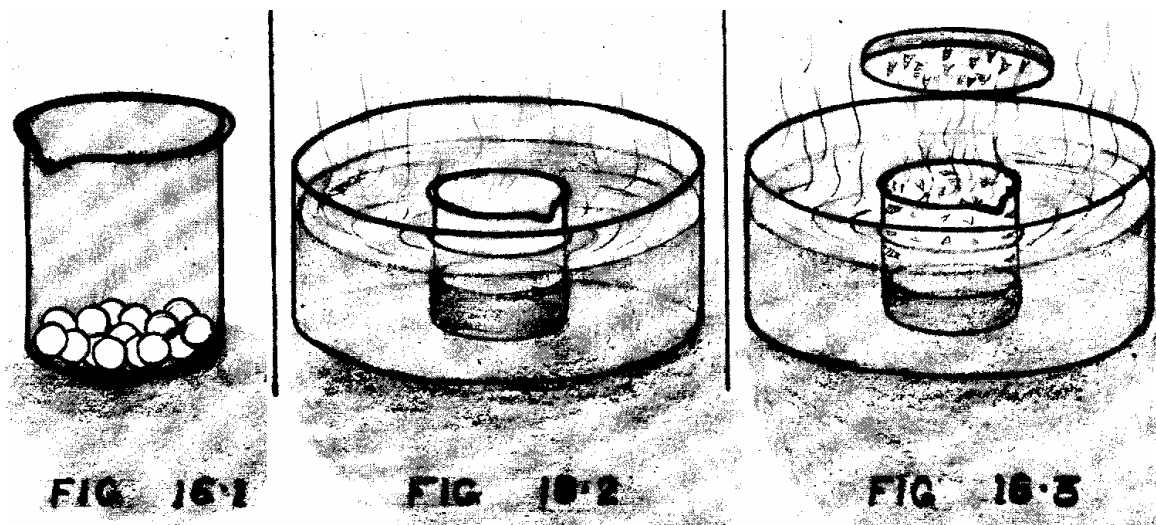
Materials

Beaker

Naphthalene balls (moth balls)

Boiling water

Piece of glass



Put a few naphthalene balls in a beaker (*Fig 16.1*). The balls are the solid state of naphthalene. Place the beaker in a vessel of boiling water. The balls melt to form a colourless liquid (*Fig 16.2*). This is the liquid state of naphthalene. Remove the liquid from heat. You see that it solidifies.

Place the beaker in boiling water again. Hold a cold piece of glass over the mouth of the beaker.

What do you observe?

Beautiful tiny crystals of naphthalene are formed on the cold surface (*Fig 16.3*).

Why?

Crystals will also form on the sides of the beaker if it is removed from boiling water.

You are already familiar with the three states of water. Make your conclusions.

17 Spy through Walls

Materials

Thick cardboard

Sharp blade

Four rectangular mirrors (8 cm x 5 cm)

Brick

Plasticine (or any modelling clay)

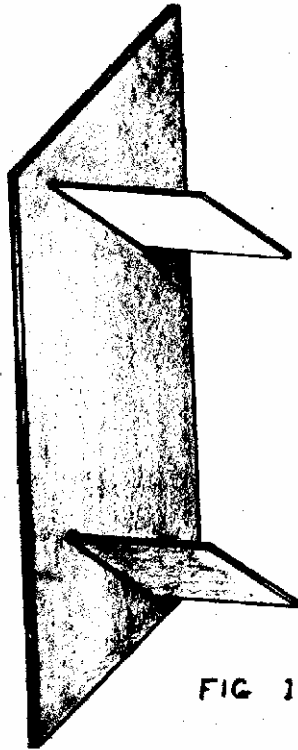


FIG 17-1

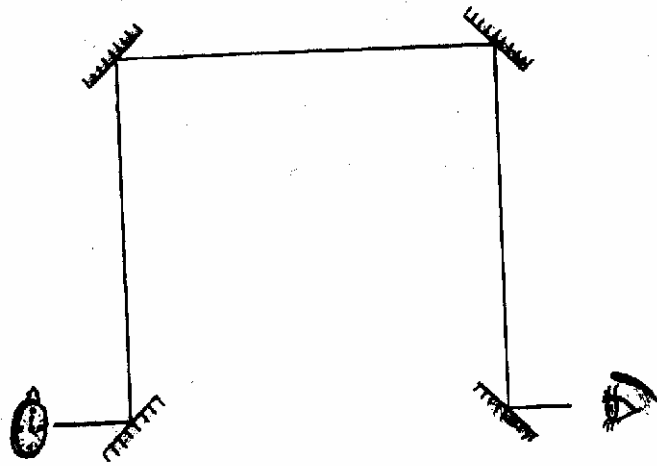


FIG 17-2

Cut out two pieces of cardboard about 27 cm x 7 cm. (This size will depend on the size of the mirrors).

At 7 cm from either end, draw lines across the breadth of one of the pieces. This gives two squares, one at each end.

Draw diagonals parallel to each other on the squares.

Using a sharp blade cut a slit along the middle of each diagonal. The slit should be slightly shorter than the breadth of the mirrors.

Insert a mirror in each of the slits with the shining faces of the mirrors facing each other (*Fig 17.1*).

Repeat the same for the second piece of cardboard.

Place a brick upright on its smallest face as the base.

Try to look through the brick. You do not see anything on the other side.

Use plasticine to arrange the two cardboard pieces (with mirrors) also in an upright position, one on either side of the brick, as shown in *Fig. 17.2*.

Keep any object; say a watch, at the level of the lower mirror on one side of the brick, look at the lower mirror on the other side. You can now 'spy' through the brick wall (*Fig 17.2*).

You may have to adjust the cardboards slightly to get the object in view.

If you use only one cardboard (with mirrors) you can spy around corners and over fences. The submarine crew does the same by means of the periscope.

Draw a diagram showing the path of light from the object to the eye in this case.

18 Kaleidoscope

Materials

Three equal rectangular mirrors (20 cm x 5 cm)

Cello tape

Thick paper (e.g. chart paper)

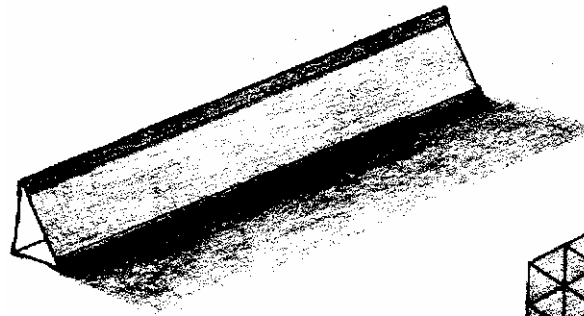


FIG 18.1

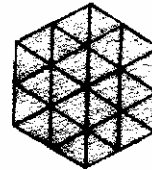


FIG 18.3

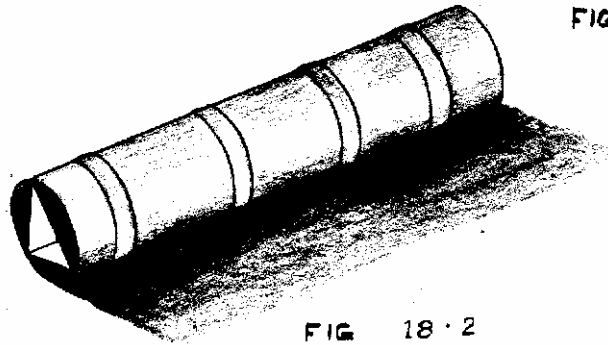


FIG 18.2

Take three rectangular mirrors each about 20 cm long. Tape them to one another along their length with the shiny surface on the inside. You get a long prism (*Fig 18.1*).

Roll and tape a piece of thick paper into a cylindrical tube such that the prism of mirrors will sit snugly into it (*Fig 18.2*).

The kaleidoscope is ready.

Place one end of the kaleidoscope on a piece of white paper and look through the other end.

What do you see?

It is as if you are looking at a wall of mirrors (Fig 18.3).

From where have all these mirrors come?

Draw a random coloured pattern on a piece of paper. Look at it through the kaleidoscope. You get beautiful symmetrical designs. Copy those you like most.

Make several designs of your choice and have fun.

Keep small coloured objects between the mirrors and look again.

You can have beautiful ever changing patterns and designs with the kaleidoscope.

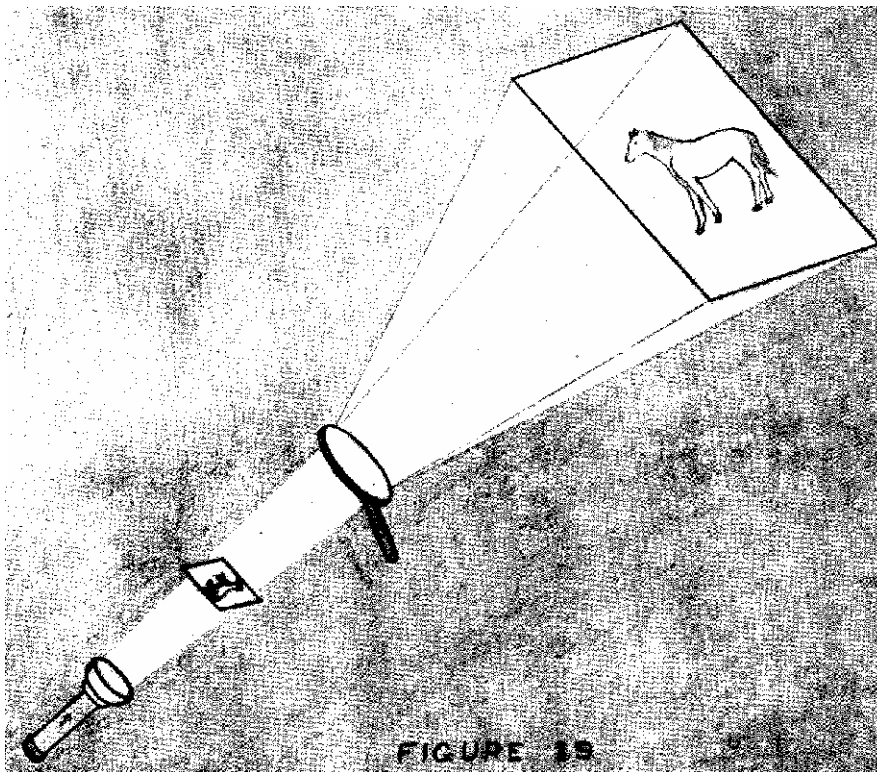
19 Simple Projector

Materials

Convex lens (ordinary magnifying glass)

Transparent cellophane paper

Flashlight



Take a convex lens and find its focal length thus: Hold the lens between a well lighted distant object seen through a window and a white wall. Move

the lens backwards and forwards till you get a sharp image of the object on the wall. Measure the distance between the lens and the wall. This distance is called the *focal length* of the lens.

Draw a small picture in ink on transparent cellophane paper. This will be called the 'slide'.

Hold the slide *upside down* at a distance of about one and a half times the focal length of the lens.

Darken the room by closing windows and drawing curtains.

Let a friend shine a flashlight through the slide and the lens towards the wall.

Move the slide back and forth and watch the picture on the wall.

What do you see?

When the slide is at the right distance from the lens you get an enlarged sharp image of the slide on the wall (*fig 19*).

You have made a simple projector.

If you wish to have a *portable* projector, make holes of the proper size on the opposite sides (or ends) of a box (or tube) for the lens and the flashlight and a slot (with proper frame) on the top for the slide. Make sure that the light falls well through the slide and the lens.

Do you know why a projector is able to give an enlarged image? Where else is a convex lens commonly used?

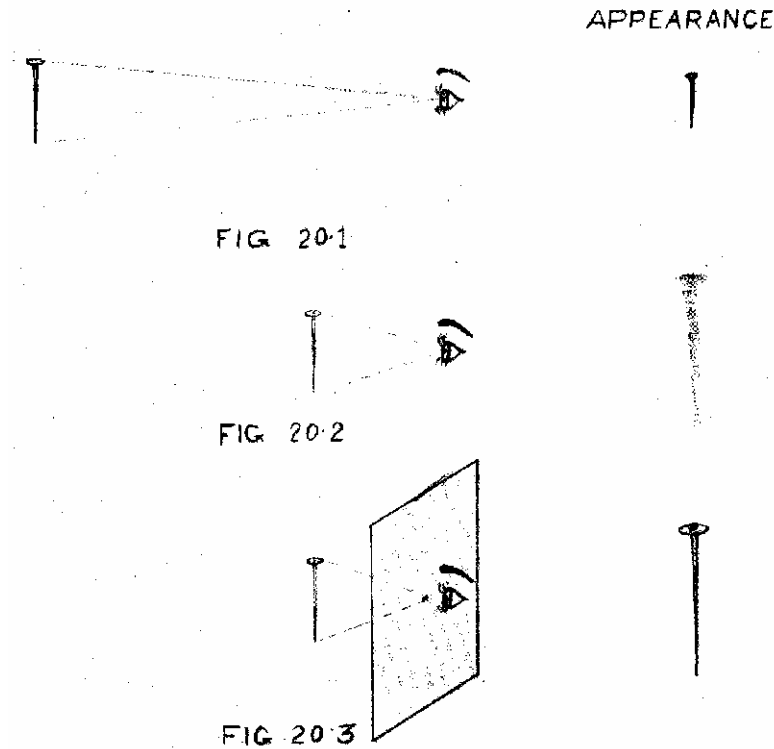
20 Pinhole Magnifier

Materials

Pin

Thick black paper (chart paper will do)

25 p coin, 50 p coin



Hold an ordinary pin at arm's length and look at it (*Fig 20.1*). Slowly bring the pin nearer and nearer to the eye. What do you observe?

The pin *appears* to grow bigger and bigger but it cannot be seen clearly. The outline of the pin is hazy (*Fig 20.2*) because the eye cannot focus at a distance less than about 10-15 cm.

Cut a piece of size 8 cm x 3 cm from thick black paper and make a small hole at its centre with the tip of a pin. This will be our pinhole magnifier.

Hold the magnifier very close to your eye and look at the pin again.

Again the pin appears bigger and bigger and finally looks like a nail. But now the outline of the pin is *always* sharp (*Fig 20.3*).

Can you suggest how this happens?

Now look at a 25 p coin through the pinhole.

Can you make it look like a 50 p coin?

Has the 25 p coin really changed into 50 p coin?

Next look at your name written in as small letters as you can write. Let the pinhole magnifier bring it to normal size.

Compare this magnification with that by a reading lens.

21 Telescopes

Materials

One double convex lens of focal length 2.5 cm (+40 dioptries)

One double convex lens of focal length 20 cm (+5 dioptries)

Black chart paper

Pair of scissors

Stapler

Cello tape

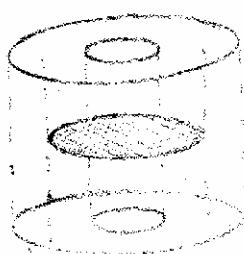


FIG 21.1

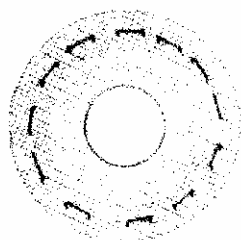


FIG 21.2

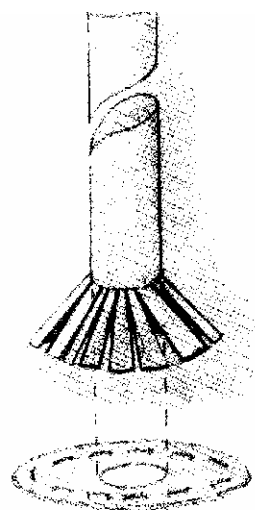
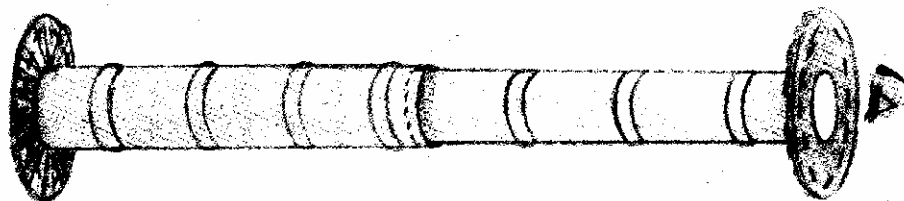


FIG 21.3



Find the focal lengths of each of the two lenses by the method of Activity 19, and check if they are about 2.5 cm and 20 cm. Let us call them f_1 and f_2 respectively.

Measure the diameter of the two lenses, say d_1 and d_2 ($d_1 < d_2$).

Cut out two flat rings of black chart paper with inner diameter 1 cm less than and outer diameter 1 cm greater than d_1 (Fig 21.1).

Keep the lens f_1 between the two rings and staple the rings all round (Fig 21.2). Repeat for the lens of diameter d_2

Roll a piece of black chart paper into a tube 20 cm long and diameter 1 cm less than d_1 . Tape it so, that it stays in the form of a tube.

Cut the tube lengthwise up to 2 cm symmetrically at a number of points at one end. Open the tabs out. Staple the lens f_1 to this end

Roll another piece of black chart paper into a tube which has the same length as the first one and which will slide over the first tube. Staple the lens f_2 to one end of this tube in the same way as you stapled f_1 to the first tube.

Push the free end of one tube into the free end of the other tube. The telescope is ready (*Fig 21.4*).

Point it towards distant objects. Look through f_1 and face f_2 towards an object. Move the tubes in and out to get a sharp image of the object.

Sketch the phases of the moon as you see them in your telescope every day.

22 Compound Microscope

Materials

One double convex lens of focal length $f_1 = 2.5$ cm (+40 dioptries)

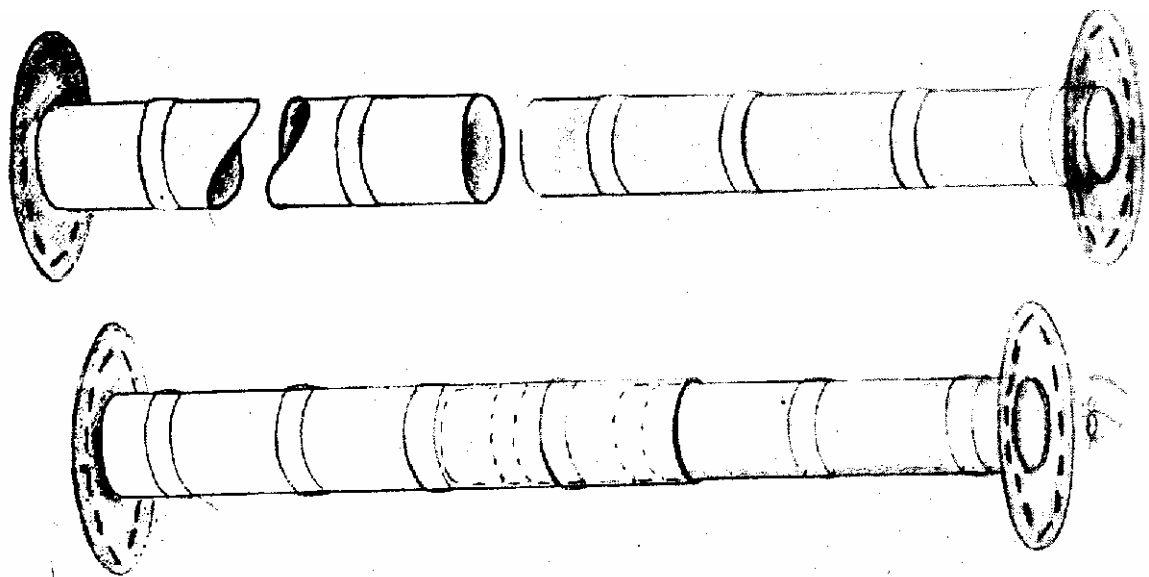
One double convex lens of focal length $f_2 = 10$ cm (+10 dioptries)

Black chart paper

Pair of scissors

Cello tape

Stapler



Check the focal lengths of the two lenses and staple them in their masks. Prepare two tubes of length 15 cm each from black chart paper and staple the lenses one to one end of each tube exactly as in Activity 21 (Fig 22.1).

Slide the open end of one tube into the open end of the other tube (Fig 22.2).

The microscope is ready.

Place a small object say the point of a pin, hair, an ant, etc on a piece of white paper. Illuminate the object well.

Point lens f_1 towards the object. This lens is called the object *glass* or simply the *objective*.

Look through lens f_2 . It is called the eyepiece or simply the *ocular*.

Adjust the tubes In and out so as to get a sharp image.

What do you observe?

The image is much larger than the object. It is said to be *magnified* and allows you to see details that were not visible to the naked eye.

The microscope is an instrument for magnifying and observing very small objects. It is an asset when we want to see objects that are too small to observe directly in detail. It shows us the wonders of the world which are quite invisible otherwise. It is widely used in medicine and other sciences.

Use it to study

- (a) Your skin, hair, nails
- (b) Drop of water from a tap and a pond

- (c) Structure of paper
- (d) Structure of fibres (cotton, rayon, nylon, wool)
- (e) Pollen grains in a bit of pollen
- (f) Stomata of leaf
- (g) Spider's web
- (h) Crystals of sugar and salt

Do you know how a microscope magnifies? Think of many more things to observe.

23 Big Beautiful Bubbles

Materials

Water (preferably distilled)

Soap (preferably liquid)

Glycerine

Dish

Straw

Paper cup

Wire

Funnel



FIG 23.1

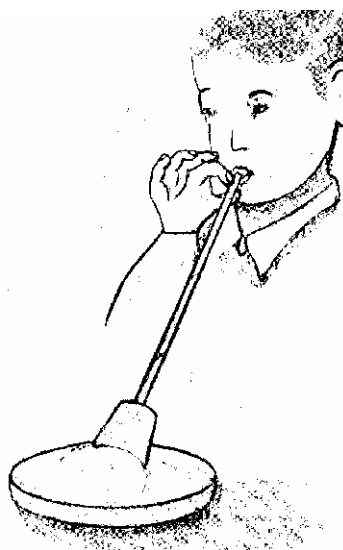
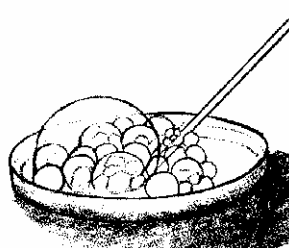
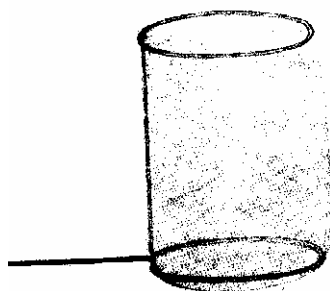


FIG 23.2



You can blow big beautiful soap bubbles if you work with care and without haste. Slow steady blowing gives best results.

Take two cupfuls of cold water, preferably distilled*. Add two large spoonfuls of liquid soap and half a cup of glycerine to it. Stir thoroughly. Remove any scum or small bubbles that may form on the surface.

Split a drinking straw at one end in the form of a cross. Dip the straw into the solution and blow *gently* in at the other end. The bubbles get filled with the air from your lungs and fill up the surface of the container (*fig 23.1*). Lift the straw out and you can have bubbles floating around. Illuminate the bubbles properly and watch the lovely colours.

Take a paper cup and another straw. Make a hole in the bottom of the cup just large enough so that you can blow through the straw into the cup.

Dip the mouth of the cup into the bubble solution and blow through the straw. The wide mouth of the cup will create much larger bubbles than does the small mouth of the straw alone (*Fig 23.2*).

Make a wire frame with two rings connected by a handle. Dip one ring into the soap solution and blow an ordinary round bubble into it. Keep blowing till the bubble touches the second ring. You now have a cylindrical bubble (*Fig 23.3*). Watch the different colours and contours it goes through before bursting. It is fascinating. Work with frames with different distances between the rings, and with frames of different shapes.

Place a flower in the middle of the surface of the soap solution and cover it with a glass funnel. Blow into the stem of the funnel and slowly lift it up to get a bubble. When the bubble is large enough, tilt the funnel and you have a flower under a transparent semicircular colourful soap bubble. You can even blow bubbles within bubbles (*Fig 23.4*). There is almost no end to the variety of patterns you can form with bubbles.

* If you do not have distilled water, boil water and cool it. Remove any scum.

**Ordinary washing soap also works well. You have to make a real *thick* solution.

+ Glycerine increases the life of the bubbles.

24 Light Colours mix by addition

Materials

Three flashlights

Cellophane paper, red, blue, green coloured

Cello tape

White paper

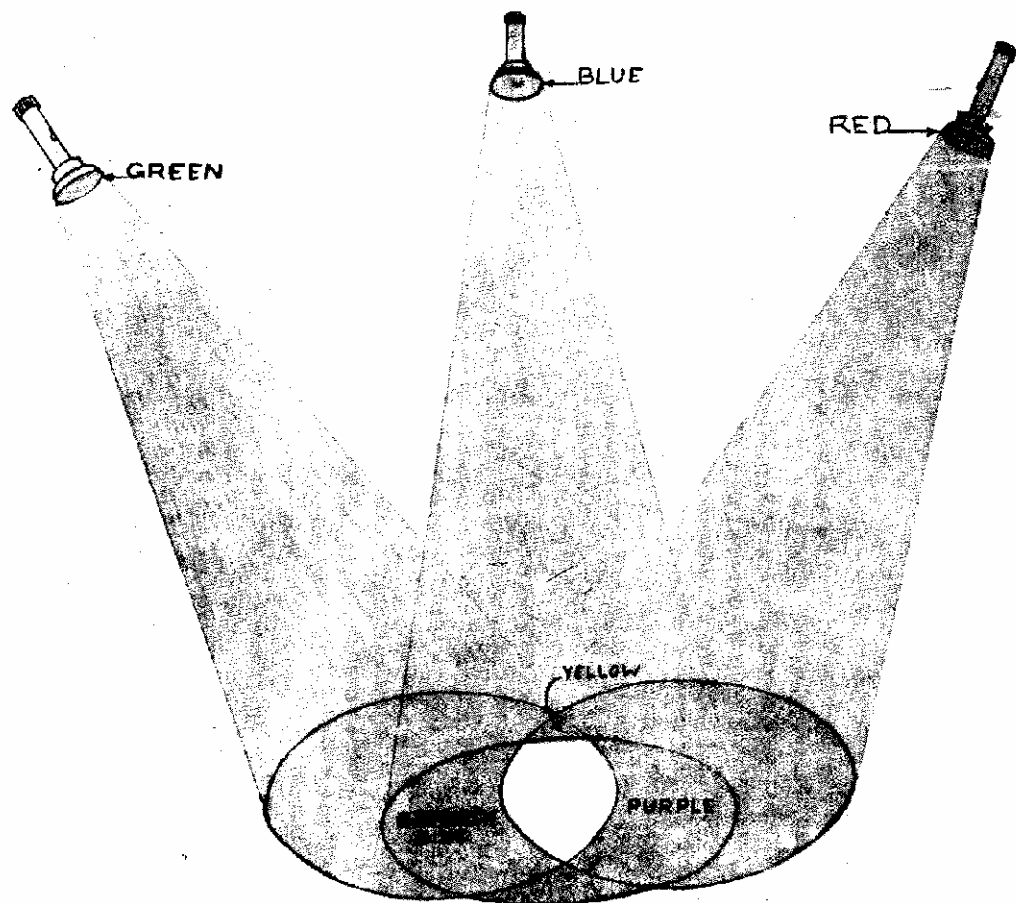


FIGURE 24

Hold the red cellophane paper before your eyes.

What do you see?

Everything looks red through it.

Why? Because it absorbs all colours except red.

Similarly, everything looks blue through blue paper and green through green paper.

Why?

Tape a small piece of red cellophane paper over a flashlight, blue cellophane paper over another flashlight and green cellophane paper over a third one.

Shine all the three flashlights on a sheet of white paper.

What do you see?

The three combine to make almost white light (*Fig 24*).

Why?

Now take away the blue light and mix only red and green.

What do you observe?

You have neither red nor green but yellow light.

Similarly mix blue and red and you get magenta (purple-red). Mix green and blue and you get greenish blue.

Why?

You may have to adjust the proportions of the coloured tights to get the proper overlapping colours.

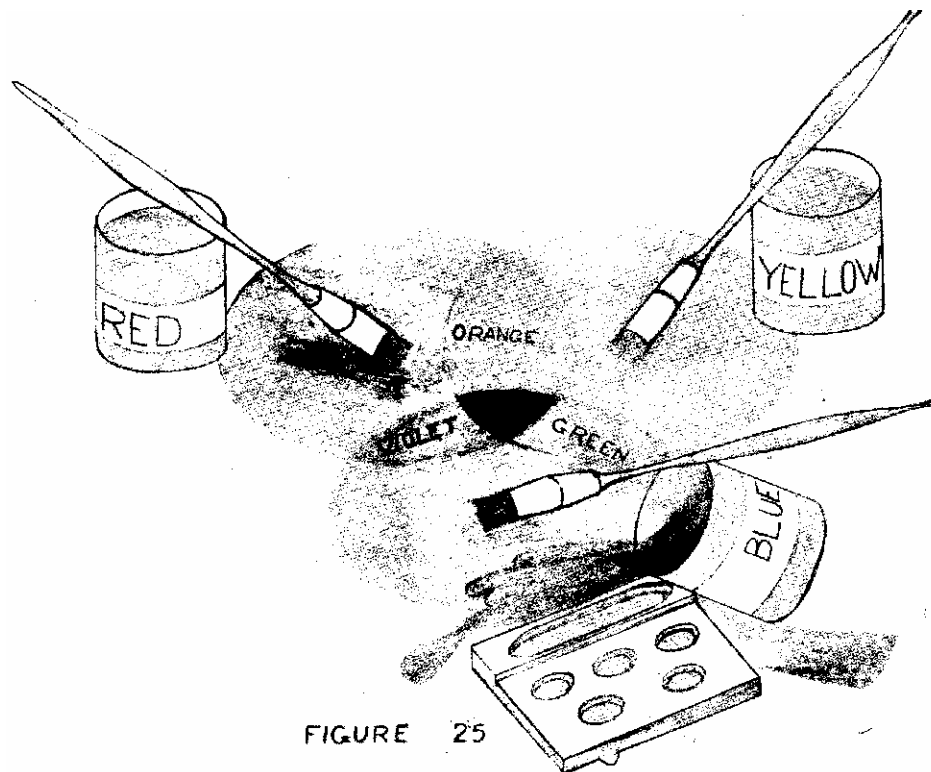
25 Paint Colours mix by subtraction

Materials

Paper

Brushes

Primary paint colours (red, yellow, and blue)



An apple appears red. Grass looks green.

Why?

Mix some red and blue paint on white paper.

What do you see?

You see violet colour.

Why?

Now mix blue and yellow paint.

You get green colour.

Why?

Next mix yellow, blue and red together.

You get black (almost) (*Fig 25*).

Why?

You may have to adjust the proportions of the primary colours to get the proper overlapping colours.

26 Magnetize Mummy's Hair Pin by Electricity

Materials

Enamelled copper wire

Pencil

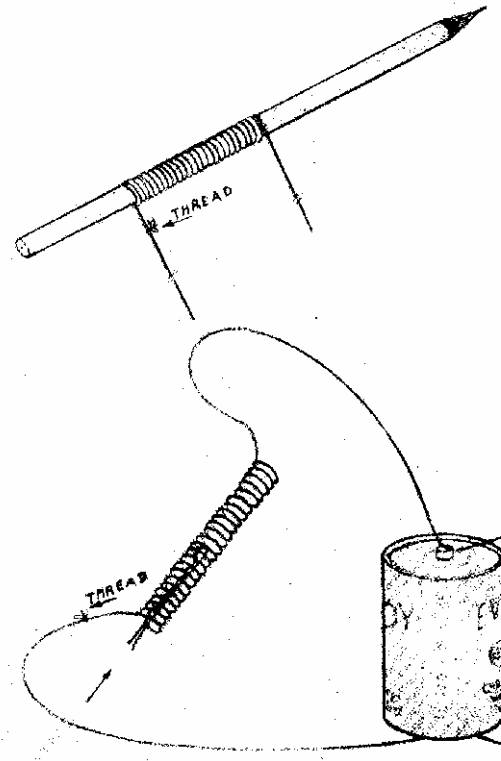
Thread

Dry cell

Cello tape

Hair pins ('bob' pins)

Pocket compass



Wind 30 to 40 turns of enamelled copper wire tightly on a round pencil in the way shown in Fig 26.1. Leave about 15 cm of wire at the beginning and the end of the coil.

Tie a small piece of thread to mark the end with which you started winding (*Fig26.1*),

Withdraw the pencil.

Scrape the insulation 2 to 3 cm from the ends of the wire.

You now have a coil of wire in the shape of a helix.

Tape the thread end of the coil firmly against the bottom of a fresh dry cell.

From this end insert a hair pin completely into the coil, head end of the pin first.

Now touch the other end of the coil to the top of the cell (*Fig 26.2*). Hold it there for a few seconds and disconnect.

Remove the pin.

The pin is now a magnet with its head a North Pole.

Check its poles with a pocket compass, or by suspending it by a thread.

Magnetize one more bob pin similarly and mix the two with some unmagnetized pins.

Do they look the same or different?

Can you separate the magnetized pins from the rest?

27 Bottle Compass

Materials

Wide-mouthed bottle with lid

Thick paper

Pair of scissors

Glue

Thin long nail

Sewing thread

Cello tape

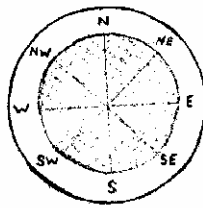


FIG 27.1

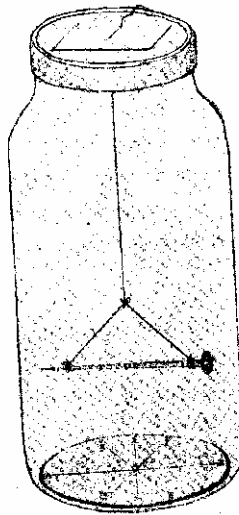


FIG 27.2

Take a bottle with a wide mouth.

Cut a circular card from thick paper to fit the Inside bottom of the bottle.
Mark geographical directions on the card (*Fig 27.1*).

Paste the card on the inside bottom of the bottle.

Take a thin long nail and magnetize it by electricity as In Activity 26, so that its head is the N-seeking pole. Tie a thread about 25 cm long to the nail so that it balances horizontally.

Using cello tape, suspend the nail from the lid of the bottle about 2 cm above the card (*Fig 27.2*).

Seal the jar with cello tape.

The bottle compass is ready.

It is extremely sensitive.

Work away from steel and iron objects.

Why?

Allow the nail to come to rest and check the direction of rest with a compass.

What do you find?

The nail always rests in the NS direction with the head pointing north.

Use it as a direction indicator.

28 Make your own Electromagnet

Materials

Enamelled copper wire

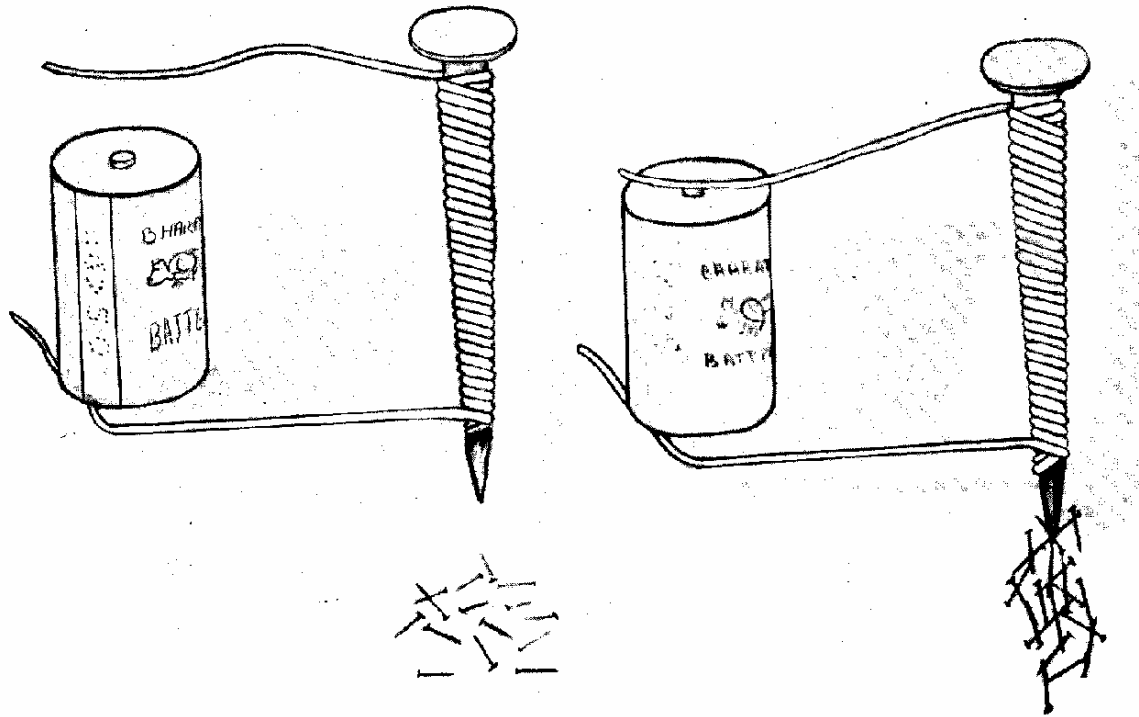
Soft iron nail (or bolt)*

Tape (or rubber band)

Sand paper

Pins (or nails or steel thumbtacks)

Dry cell



Leave about 25 cm at one end of an enameled copper wire and wind it carefully and neatly around a soft iron nail. Have two or three layers and finally leave another 25 cm of wire free (*Fig 28.1*). All layers should be wound in the same way (clockwise or anti-clockwise).

Use tape or rubber band to hold the wire in place.

Remove the insulating enamel from the ends of the wire with sand paper.

Put the end of the wired nail into a box of pins and take it out.

Hardly a pin comes out with it.

Why?

Put the end of the nail again into the box of pins and connect the two ends of the wire to a dry cell. Raise the nail.

What happens?

A lot of pins come out with the nail (*Fig 28.2*).

Why?

The wired nail behaves like a magnet. You have made an electromagnet.

While the electromagnet is holding the pins, disconnect the cell.

What happens?

The pins drop down (*Fig 28.1*).

Why?

*An easy way to make a soft Iron nail is to heat an ordinary Iron nail to red heat in coal fire at night, leave it there over-night and take It out in the morning.

29 Dancing Doll

Materials

Thin wire

Round pencil

Drawing pin

Thick paper

Books, boxes

Thick soft Iron bolt

Thick enamelled copper wire

High amperage cell (or battery)

Cardboard box

Paper clips

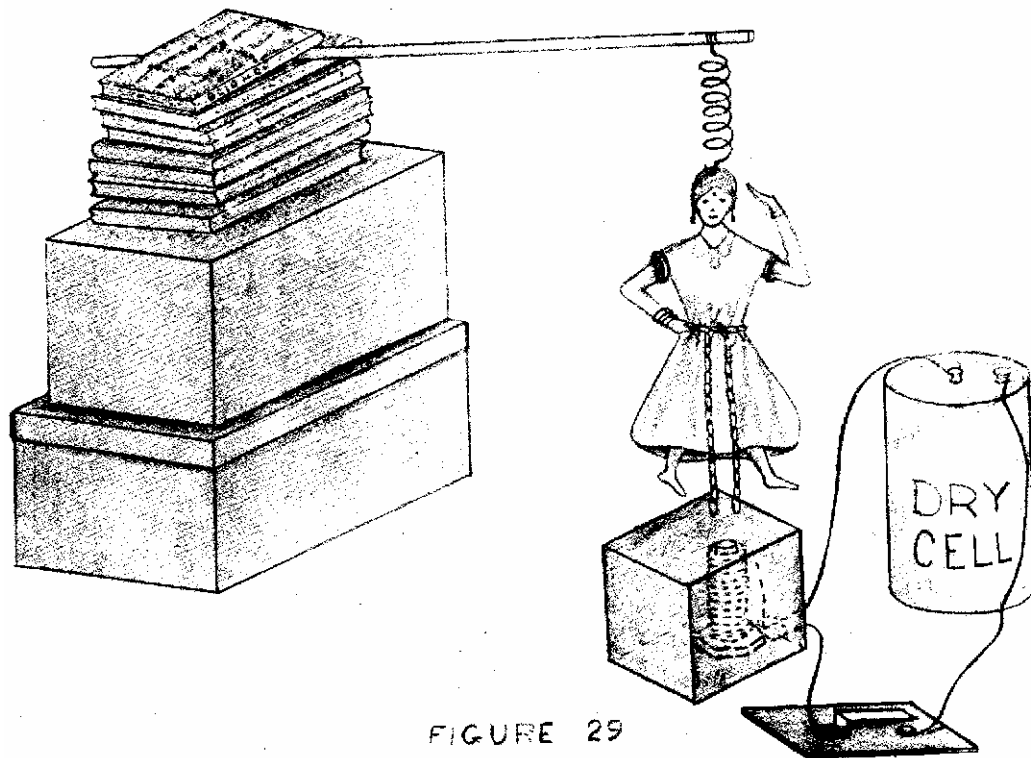


FIGURE 29

Make a coil of thin wire by wrapping it around a round pencil and withdrawing the pencil.

Attach one end of the coil to the pencil near one end with the help of a drawing pin. Cut a paper doll from thick paper and hang it from the other end of the coil.

Arrange a high pile of books and boxes, and support the pencil (along with coil and doll) from in between the uppermost two books as shown in Fig 29.

Make a strong *electromagnet* by winding five to six layers of thick copper wire around a thick soft iron bolt (see Activity 28). Connect the two ends of the wire to a dry cell through a simple switch.

Let the electromagnet be arranged upright inside a cardboard (or plywood) box.

Wrap a 'belt' of paper clips around the waist of the doll and let two strands hang down. Adjust the strands to be about 1 cm above the cardboard box (*Fig 29*).

Close and open the switch alternately.

You have a dancing doll.

The doll dances up and down and sideways.

Why?

30 Electrical Question Board

Materials

Rectangular box of stiff cardboard

Paper fasteners

Thick paper

Flashlight bulb

Connection wire

Cello tape

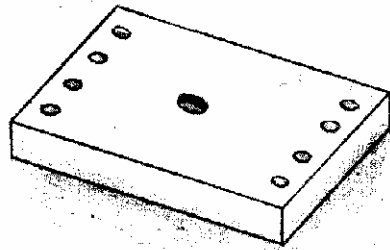


FIG 30.1

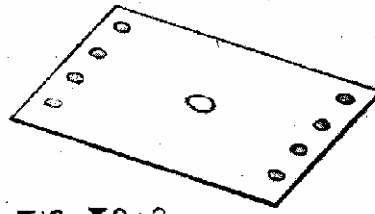


FIG 30.2

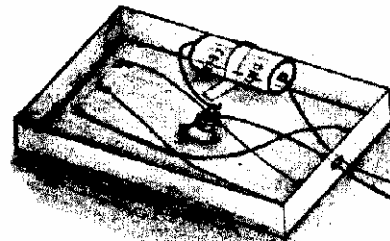


FIG 30.3

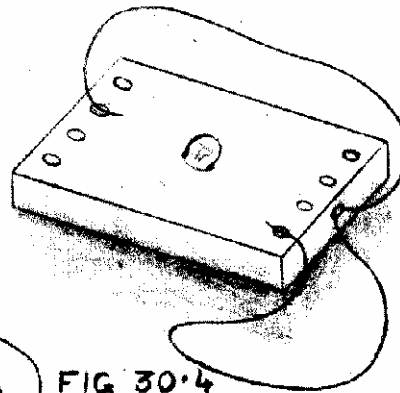


FIG 30.4

Take the cover of a rectangular box of thick cardboard. If you do not have one, make it from cardboard, plywood or boxwood. On the top of the cover (Fig 30.1),

- (a) Make a hole in the centre to hold a flashlight bulb.
- (b) Fix 4 paper fasteners near one edge and equidistant from one another. These will form the question *terminals*. Fix 4 more paper fasteners near the opposite edge and symmetrically to the first set. These will be the answer *terminals*. Make cards from thick paper of the same size as the cover. Make holes corresponding to the eight paper fastener heads, and also one for the bulb, in each card. Write questions on the left hand side and answers in a *jumbled* order on the right hand side e.g. question 2 may have answer 4 (Fig 30.2). On the *inside* of the cover (Fig 30.3).

- (a) Connect each question fastener by a wire to the *corresponding* answer fastener.

- (b) Tape a fresh dry cell to one side.

- (c) Place the bulb in position from the front.

- (d) Connect one end of the cell to the base of the bulb by a short piece of wire. Tape one end of a long piece of wire to the other end of the cell. Tape one end of another long wire around the grooves of the bulb. Tape the bulb so that it sits snugly in the hole.

Take out the two long wires through a hole in the side of the cover. The *electrical question board* is ready.

The free ends of the two long wires will be the *check terminals* (Fig 30.4) Place any question card on the top. Whenever the check terminals touch a question terminal and the *corresponding* answer terminal the circuit is completed and the bulb will light.

Try it on your friends. Let a friend choose any question and try to give the answer. The electrical question board will check if the answer is correct or not.*

*Note for teachers: By using cards with 10-15 question-answers, such a board may be used as a learning aid particularly for backward children. Of course, in such a case the questions must form part of a larger scheme of programmed learning, and they must not be informative or general knowledge type.

31 Control the Brightness of a Flashlight Bulb

Materials

Pencil

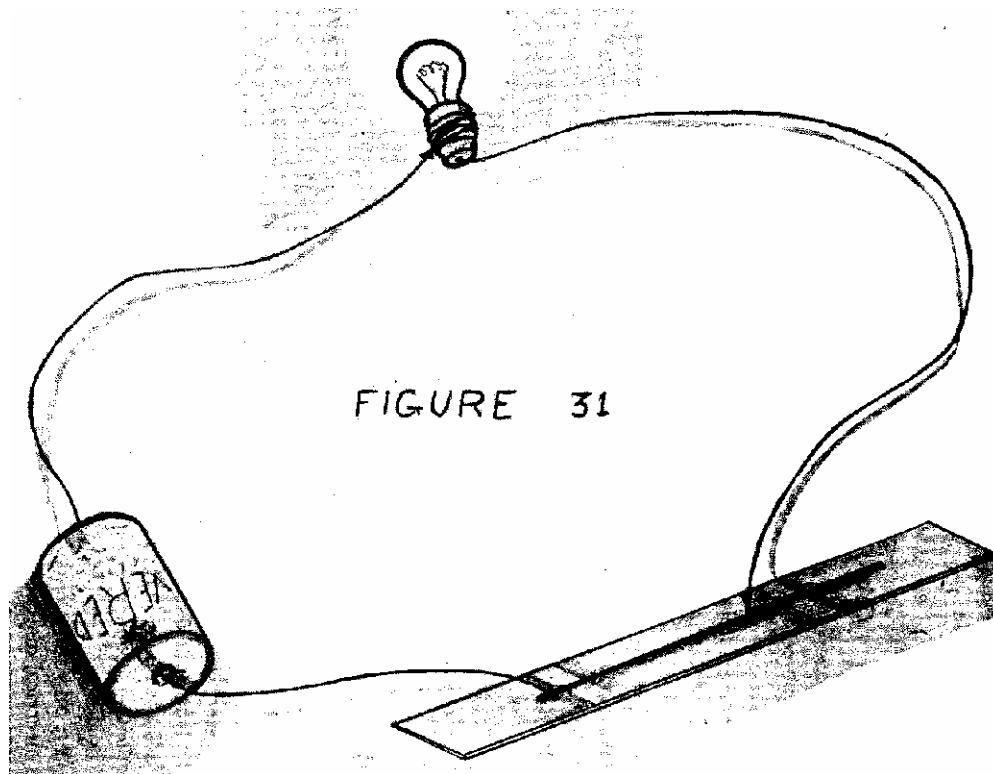
Flat piece of wood (or plastic or thick paper)

Cello tape

Flashlight bulb

Dry cell

Connection wires



Carefully take out the lead from a pencil without breaking and tape it to a flat piece of wood.

Tape one end of a piece of connection wire to one end of the pencil lead and the other to the top of a dry cell.

Tape one end of another piece of wire to the bottom of the dry cell and twist the other end of the wire around the grooves of a flashlight bulb.

Tape a third piece of wire to the base of the bulb, and touch the pencil lead with the free end.

What do you see?

The bulb lights up (*Fig 31*).

Slide the wire end along the pencil lead.

What happens?

The brightness of the bulb changes.

If you increase the length of the pencil lead in the circuit, /e the path of the current, the brightness of the bulb decreases and vice versa.

Why?

* Always remember to remove insulation (plastic or rubber or enamel) from the ends of the connection wires.

32 Copper-coated Iron Nails

Materials

Copper Sulphate

Water

Iron nails

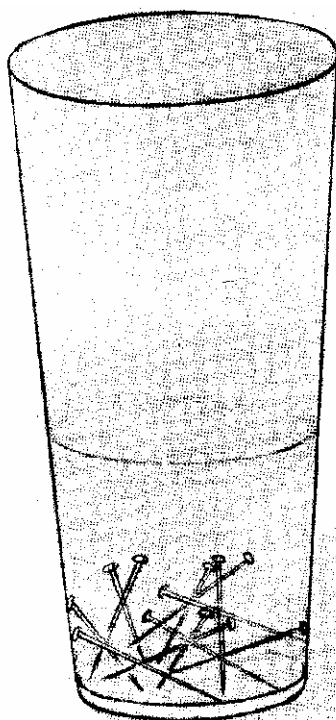


FIGURE 32

Make a fairly strong solution of copper sulphate in water. (A solution made in water is called 'aqueous solution').

Dip a few iron nails in the solution for a few seconds (*Fig 32*). Take them out, wash under a tap, and look. What do you find?

The nails get coated with copper. The copper from the solution has somehow got onto the nails.

Put the nails back into the solution.

Take them out and look again. The nails now have a thicker coating.

Can you think of any advantage of copper-coated iron?

If you want a silver coat, place the article in a *used* bath of hypo*(sodium thiosulphate) for two to three hours. Remove from the solution, wipe gently

and give a slight rub with a soft cloth. The article will have a nice silver shine.

Hypo is used in photography as a fixer for negatives.

33 Etching by Fire

Materials

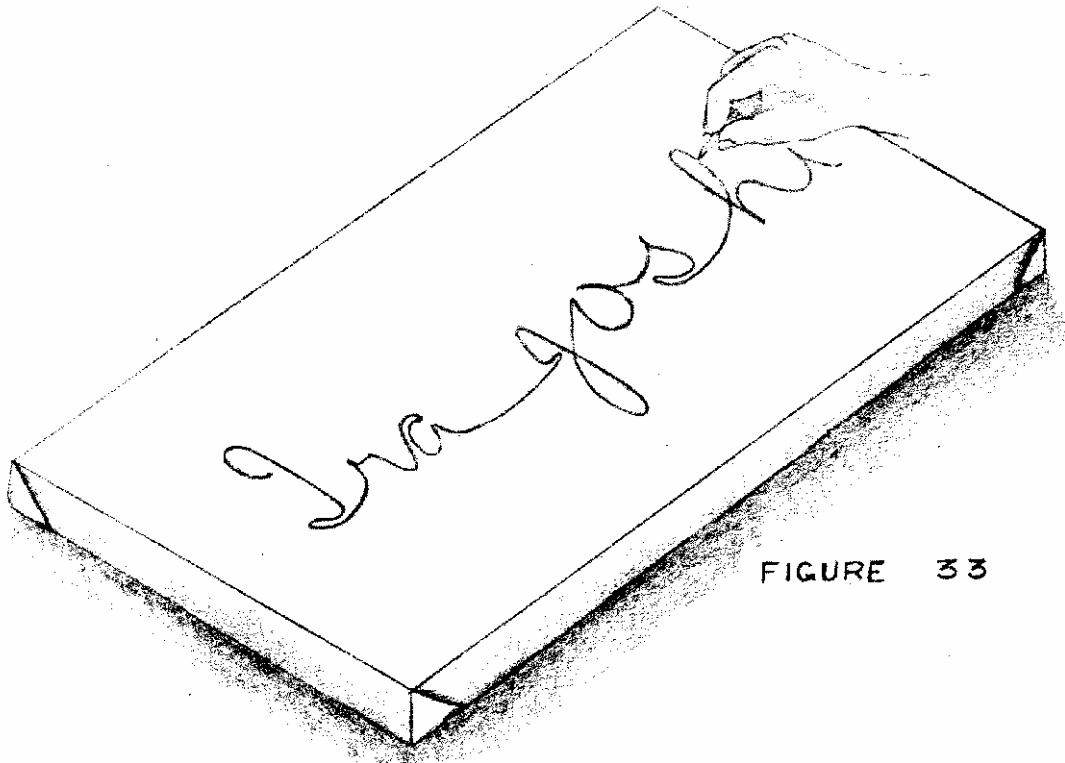
Potassium nitrate

Water

Plain white paper

Fine paint brush

Box of matches



Prepare a strong solution of potassium nitrate in water.

Use the solution to write a name or draw a design on a large sheet of plain white paper with a paint brush. Mark the starting point.

The name or design should be in a continuous *line* with no break at any point. Let the writing / drawing dry completely. It will be almost invisible.

Fold down the edges of the paper about 2cm all round. The part of the paper with the design should now be raised above the edges (Fig 33). Snip off corners so that folding is easy.

Sharpen one end of a match stick and light it up with another match stick. Put out the flame and immediately touch the starting point of the design with the glowing tip.

What do you see?

The paper will burn along the invisible line. The fire will etch the design.

34 Sun clock

Materials

Cylindrical empty tin with lid

Shears (tin scissors)

Quickfix

Cardboard

A bead

Wire (or string)

Cello tape

Plasticine

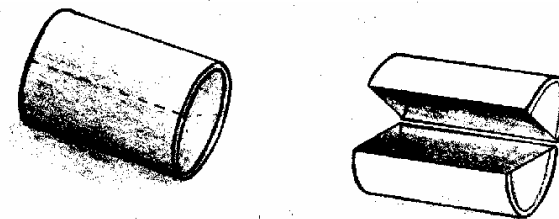
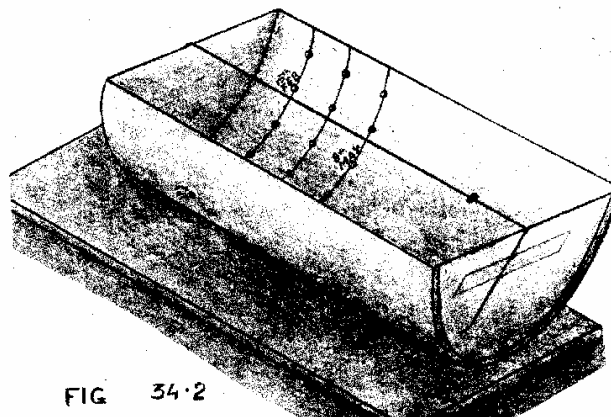


FIG 34.1



Using shears cut an empty cylindrical tin along its length into two equal halves. Cut the lid of the tin also into two equal parts.

Cover the open end of one of the half cylinders with half the lid. Use quick fix to keep the lid firmly in place (*Fig 34.1*).

You now have a half cylinder with a half-lid. Fix it to a rectangular piece of cardboard so that the whole thing can be kept on a flat surface in any fixed direction.

Pass a bead through a length of wire. Stretch the wire between the midpoints of the straight edges at the ends and fix it to the ends with eel tape.

Centre the bead on the wire. Use plasticine to keep it at one point.

The sun clock is ready.

Place the clock in sunlight on a level surface with the wire (called gnomon wire) along the north-south direction.

The shadow of the wire will show sun time.

Mark a point on the inside of the tin to indicate the shadow of the bead at a particular time. Repeat several times a day.

Join the points by a smooth curve. This curve gives the path representing the motion of the sun on that day (*Fig 34.2*).

Repeat once a month for several months from winter to summer and note the change in the shadow of the bead and hence the curves.

Observe that

- (a) As the sun moves across the sky, it does not pass exactly overhead.
- (b) The sun does not rise directly in the east and set directly in the west except for two days in a year. On other days the sun rises and sets north or south of the true east-west line.
- (c) The apparent path of the sun changes with the season. Compare the paths at different times of the year.

35 Test your Muscular Control

Materials

Plywood (or thick cardboard)

Handsaw

Drawing pins

Thick copper wire

Door bell (or flashlight bulb)

High amperage dry cell (or battery)

Connecting wires

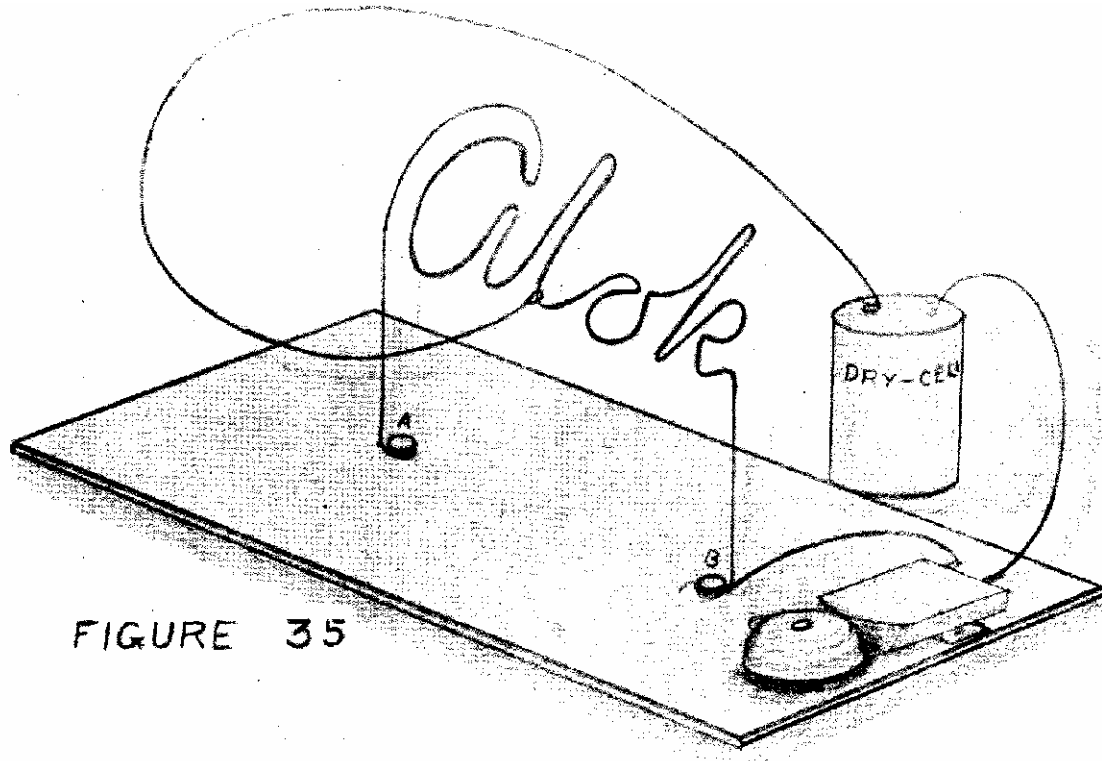


FIGURE 35

Use a handsaw to cut a piece of plywood 10 cm x 60 cm and fix two drawing pins (say A and B) to it (*Fig 35*).

Bend a long thick piece of copper wire in any pattern with close loops and tight curves. Fix the wire pattern *upright* between A and B.

Connect one end of a high amperage dry cell through a door bell or a flashlight bulb to B. Connect the other end of the cell to a long piece of wire. Form the free end of the wire into a *small* loop around the wire pattern (*Fig 35*).*

Test your muscular control by moving the loop with your hand from A to B along the loops and curves of the copper wire without touching the wire.

Every time you touch the wire, the bell will ring (or the bulb will light up).

Why?

See how many times you touch the wire.

Compete with your friends. One who touches the wire the smallest number of times has the most steady hand and the best muscular control.

*Always remember to remove insulation from the ends of connecting wires.

Explanations of Activities

When the rubber cups are pressed together a partial vacuum is created inside them. The pressure of outside air is greater than that of inside air. This difference of pressures keeps the cups together.

This is similar to the way in which Otto von Guericke demonstrated the enormous force of unbalanced air pressure with his famous Magdeburg hemispheres.

The moving air stream reduces the pressure on the top of the counter. The stronger, normal air-pressure at the bottom pushes the counter into the air-stream. The air-stream then carries it into the dish. For the same reason, tops of trees and roofs of houses are sometimes blown off when there is a hurricane or cyclone.

Before you blow, the air pressure on water in the tube and water in the tumbler is the same. So, the two levels are also the same.

When you blow strongly into the second tube, the stream of air that moves over the mouth of the first tube reduces the pressure at the mouth. The higher air pressure on the water in the tumbler forces the water up the tube. When it reaches the top of the tube, it is scattered by the moving air and forms a spray.

A perfume spray works exactly the same way. Air is moved by squeezing a rubber ball and perfume is used in place of water.

The spray gun used for painting of cars, steel furniture, etc. also works the same way.

The air rushing over the curved surface causes low pressure above the hump. The higher pressure from below the hump forces it up.

The surface of the wings of an aeroplane is curved so that this lift is provided. Of course, in the actual case, air goes past across the wing.

The moth balls are heavier than the solution of water and sodium bicarbonate.

When dropped into the solution they sink to the bottom.

When acid is added, it reacts with sodium bicarbonate and produces a gas (as seen by the bubbles) called carbon dioxide.

The bubbles of carbon dioxide cling to the surface of the balls. These bubbles lift the balls to the surface of water. Here the bubbles escape from the top of the balls into the air. So the top becomes heavier and the balls roll over. When all of the bubbles are gone the balls sink again. Again more bubbles collect on the surface of the balls and the process is repeated.

Air is much more compressible than water. When the rubber cap is pressed down, the air in the jar forces more water into the dropper making it heavier and it sinks.

When the rubber cap is released, the air pressure in the jar decreases. The air in the dropper then forces the water out. So the dropper becomes lighter and rises. This is how a submarine goes up and down.

7 The balloon pushes the air out because of its (i.e. the balloon's) elasticity. The air pushes back, thus propelling the balloon in the opposite direction. This directly illustrates Newton's Third Law of Motion: For every action, there is an equal and opposite reaction.

This is exactly how a jet aeroplane flies and a rocket is fired into space. A rocket pushes hot burning gases out of its combustion chamber (action) and the gases push back (reaction), thrusting the rocket ahead.

The difference between rockets and jet aeroplanes is that rockets carry their own oxygen supply to support combustion whereas jets get their oxygen from the air itself.

8 Compressed air from the balloon goes up the centre hole into the side holes and out of the tubes. The two air streams come out in opposite directions and exert a reaction force causing the balloon and cork to rotate. If the air streams are in clockwise direction, the balloon will rotate in an anti-clockwise direction and *vice versa*.

9 Any object when *suspended freely* from a point other than its CG always comes to rest *in* such a *position* that the point of *suspension* lies *above* the CG and the line joining the two is *vertical*. Hence, for all the holes, the vertical (found by means of the loaded string) contains the CG. So the point of intersection of the lines gives the CG.

About the CG, a body spins without a jerk. When, in any machinery, axles, wheels, pulleys, etc. are to rotate, they are 'balanced'. That is, the axis of rotation must pass through the CG. The spokes of your bicycle also are tightened equally for the same reason.

10 A body balances perfectly when supported at its CG. By attaching plasticine the CG has been adjusted to be at the nose.

11 When you push the clown down, the centre of gravity is raised from G_1 to G_2 by a height $h_1 - h_2$

FIG.

When you let go, the gravity pulls the whole object (i.e. clown + weight) down; the centre of gravity always tries to be the lowest (Activity 13 Book 2). The CG being lowest means the clown is upright (because we made the toy that way). Rocking toys work on the same idea.

12 A small effort at a longer distance (effort arm) can lift a much larger load.

The product of effort and effort arm is nearly the same as the product of load and load arm. This is the Law of Levers.

13 Copper is a good conductor of heat. When the cold coil surrounds the flame it conducts away the heat from the surroundings of the flame. This lowers the temperature and thus reduces the size of the flame. When the coil is already hot, it does not take away heat from the flame, so the flame continues to burn.

14 Metals are good conductors of heat whereas wood is a bad conductor.

When the paper is stretched around the metal rod the metal takes away the heat from the candle and the temperature of the paper does not rise too much. So it does not burn.

15 Water is a poor conductor of heat, so the heat is not conducted downwards. Also hot water being lighter than cold water, no convection currents are set up.

16 The melting point of naphthalene is 80°C . The boiling point of water is 100°C . So the balls melt when the beaker is placed in boiling water. The vapour of naphthalene is colourless and cannot be seen. Crystals are formed when the vapour strikes the cold surface and condenses into solid form. Naphthalene can exist in three forms solid, liquid and vapour in the same way as water exists in three forms:-solid (ice), liquid (water) and gaseous (vapour and steam).

17 The rays from the object strike the lower mirror of the first cardboard at 45° . This mirror reflects the light at 45° and thus turns it through 90° to the top mirror. The light now strikes the top mirror at 45° which turns the

light another 90° . The light is further turned through 90° at each of the mirrors of the second cardboard and finally is able to reach the eye (*Fig 17.2*).

18 Each mirror gives rise to an image of an object and also to the images of the Images In the other mirrors. This way the images are multiplied. The images together constitute beautiful patterns.

19 A convex lens is thicker in the middle than at the edge. It can bend light rays and form images of objects.

When the object is very far away, a small and inverted image is formed at the focus of the lens. As the object is brought nearer and nearer, the image grows bigger and bigger, becomes equal to the size of the object and then becomes even larger and larger than the object.

Convex lenses are used in reading spectacles, magnifying glasses, microscopes, telescopes, binoculars, projectors, cameras, etc.

20 The apparent size of an object depends on the angle it subtends at the eye. This angle is called the *visual angle*. As you bring the pin closer and closer to the eye the visual angle increases and the pin appears bigger and bigger. However, the eye muscles find it almost impossible to focus at distances less than 10-15 cm, and the pin appears blurred.

The pinhole limits the directions in which the light enters the eye, hence the pin looks sharper.

When one looks at motor vehicles or a train from the top of a high hill, they all look like toys for the same reason.

22 The object glass forms a magnified image of the object. This image is further magnified by the eyepiece.

24 Red cellophane allows only red light to pass through it. It absorbs light of all other colours and so everything appears red when we look through it. Similarly green cellophane allows only green light to pass through and blue allows only blue light.

When we mix lights of two colours, the two colours combine together and new colours are formed.

Lights of different colours mix by *addition*.

When lights of red, blue and green colours are mixed together in the right proportions, almost white light is obtained.

25 A red apple appears red because when light falls on it, its skin absorbs most of all colours except red and reflects mostly red and only a little of

other colours. So the main colour that the eye sees is red. Similarly, green grass reflects mainly green.

When you mix red and blue paints, the red paint absorbs blue and yellow and the blue paint absorbs red and yellow. Neither absorbs all of the violet light that strikes; so the mixture appears violet. Similarly when you mix blue and yellow colours, the blue absorbs yellow and red and the yellow absorbs blue and red but neither absorbs all of the green. So, the mixture appears green. Paint colours seem to mix as if by subtraction.

When red, blue and yellow, the three primary colours in paint are mixed in the right proportions, they together absorb *all* the colours of light in the spectrum and hence the mixture reflects no colour. It looks black.

26 An electric current in a coil produces a magnetic field around the coil. This field is the strongest along the axis of the coil. The hair pin gets magnetized by this field. Its external appearance does not change.

In the mixture of magnetized pins with unmagnetized pins, any two pins will be either attracted to each other (if one is magnetized and the other is not) or not affected (when both are unmagnetized). Only two magnetized pins will repel / attract each other, depending upon whether like/unlike poles are near.

27 A magnetized object when left to itself will always take the NS direction because of the magnetic field of the earth.

Steel and iron objects will affect the direction of rest of the nail and it will not indicate NS correctly.

28 An electric current has its own magnetic field. The field in the middle of a coil of many turns is very strong indeed. This causes the nail to become a magnet which in turn attracts the pins.

The nail is to be called a temporary magnet because it loses most of its magnetism when the electric current in the coil is switched off,

29 Every time you close the switch the circuit is completed and there is a current in the wire around the soft iron bolt. The bolt is magnetized and pulls the paper clip strands. So the doll is pulled down.

When the switch is opened, the bolt is no longer a magnet and the clips are no longer attracted. The doll goes up because of the spring at the top and wobbles here and there.

31 When the free end of the wire touches the pencil lead the current can complete its path (circuit) from one end of the cell through the flashlight bulb, pencil lead and to the other end of the cell. So the bulb lights up. The

longer the part of lead in the circuit the greater is the resistance in the circuit and smaller the current (Ohm's law). So the bulb glows dimmer. (Pencil lead is not really lead metal, it is graphite.)

32 Iron nails rust easily. Coating saves the iron. Of course, iron articles in daily use (buckets, corrugated sheets, water pipes, etc) are coated with zinc rather than copper. It is much cheaper.

35 When the loop touches the wire, the electrical circuit is completed and the bell rings (or the bulb lights up).

End